Effect of Using Sunflower Emulsified Oil on Physical , Chemical and Biological Properties in Low Fat Beef Burger .

El-Sherbini ,Y. I.; A. M. Hassan ; Mona M. Khalil and Rania El-Gammal
Food Industries Dept., Faculty of Agriculture, Mansoura University

ABSTRACT

The purpose of this study was to assess the effects of added Sunflower Emulsified Oil (SEO) as fat replacer in preparing low fat beef burger by substitution of fat at the ratio of 5, 7.5 and 10 % respectively. Gross chemical composition, physical properties, cooking characteristics namely Texture Profile Analysis (TPA), shrinkage, cooking loss and Biological evaluation were made. Addition of Sunflower Emulsified Oil (SEO) increased the moisture, protein, carbohydrates and decreased ether extract, ash, shrinkage and cooking loss in compare with control beef burger sample. Significant differences were observed in TPA for beef burger. In low fat beef burger prepared with SEO, Total cholesterol (TC), Triglycerides (TG), HDL-C and LDL-C reached 78.47, 174.73, 33.53 and 9.99 mg/dl respectively compared with positive control group 98.37, 224.50, 17.80 and 35.67 mg/dl respectively. In conclusion, Sunflower Emulsified Oil (SEO) is effective in improving chemical, physical and functional properties of beef burger and also, had a hypolipidemic effect on experimental rats.
Keywords: low fat beef burger, fat replacer, sunflower emulsified oil

INTRODUCTION

Edible Fats in meat products processing played an effective role meat emulsion stability , providing flavor, juiciness and desirable mouth feel (Vural *et al.,* 2004 and Choi *et al.,* 2010).

Nowadays , many consumers have been eliminated their dietary fats and calories intake due to their health concerns . This phenomenon will encouraged meat technologists to process and produced different variety of low-fat meat product formulae, with a good economic value and desirable palatability (Candogan and Kolsarici, 2003).

Recently , other studies have been assured the relevance between meat consumption and increased sufferance of serious health problems , disturbance such as, colorectal cancer and coronary-heart disease (CHD) (Ferguson, 2010).

Seidell (1998) observed that dietary fat has an influence effect in gaining weight and expansion , outgrowth of obesity that is greater than what would be expected on the basis of fat's energy value .Different trials were carried out to try explain the correlation between dietary fat intake and obesity.

obesity epidemic is now considered a public health crisis. The main chronic diseases directly related to obesity include: cardiovascular disease (CVD), Type 2 of diabetes mellitus (T_2DM), cancer, gallbladder disease and osteoarthritis (Luo *et al.,* 2007). Additionally, animal fat provides high amounts of saturated fatty acids and cholesterol (Pappa *et al.,* 2000 and Ozvural and Vural, 2008).

Generally, Dietary fats were found in both of plant and animal foods. Fats provides calories and essential fatty acids and help in the absorption of the fat-soluble vitamins A, D, E, and K.

A healthier meat products could be prepared by reduction and substitution of animal fats with vegetable oils and non-protein ingredients like dietary fiber, isolated soy protein, carrageenan and konjac. Also, a reduction in saturated fatty acids and cholesterol intake is now a world-wide recommendation (Anon., 2008).

Fat replacers namely gums, inulin, maltodextrins, oatrim and olestra were used in the reformulations of meat ingredients, while starch used as carbohydrate-based fat replacers in different meat products. Fiber can provide integrity structural, enhance volume, moisture holding capacity, adhesiveness and extent shelf stability in fat products (Tokusoglu and Unal, 2003).

Sunflower one of four major excellent oil seed crops cultivated and produced around the world (Pereyra-Irujo and Aguirrezabal, 2007) and considered as excellent source of fatty acids in reducing risk of cardiovascular disease (Flagella *et al.,* 2002).

So, this research was aimed to achieve the following objectives:
1. Preparing low fat beef burger formulae using sunflower emulsified oil with different ratios.
2. Biological evaluation of fat replacers on blood glucose, lipids profile, liver and kidney functions.

MATERIALS AND METHODS

Materials
Meats and Fats

Raw meat and fat obtained from top round cut from beef carcasses were purchased from El-Mansoura city, Dakhaleia Governorate, Egypt. Visible surface fat and connective tissue were manually eliminated to yield a fat content of 2.51% (on wet weight basis) measured by Soxhlet extraction (AOAC, 2005). Raw meat and fat were ground separately in a meat grinder for the preparation of burger formulations.

Fat replacer

Sunflower oil (Crystal) was obtained from local market, EL Mansoura city, Dakhaleia Governorate, Egypt.

Spices mixture

Spices mixture was prepared using equal weights of black pepper, Chinese cubeb, paprika and nutmeg were collected from local market, EL Mansoura city, Dakhaleia Governorate, Egypt.

Other additives

Salt, powder from onion, garlic, parsley, corn starch and rusk were purchased from local market, EL Mansoura city, Dakhaleia Governorate, Egypt. Sodium tripolyphosphate, mono sodium glutamate and sorbic acid were obtained from El Naser Pharmaceutical Chemicals

Co., Abu Zaabal, Kalyoubia, Egypt and EL-Gomhouria Co. for Trading in Medicines, Chemicals and Medical Supplies, EL Mansoura, Dakhaleia Governorate, Egypt.

Emulsifier

The emulsifier type Palsgaard contains mono-diglyceride of fatty acids E471, cellulose gum E466, locust bean gum E410, guar gum E412 and carrageenan E407. The emulsifier was obtained from Al-Amreety Co. for Importing Edible Materials, EL Mansoura, Dakhaleia Governorate, Egypt.

Experimental animals

Fifty five male Sprague-Dawley rats weighing between 110-130 g were obtained from the Animal Laboratory, Faculty of Medicine, Mansoura University, Egypt.

Kits for the biological evaluation

Kits used in the determinations of serum glucose, total serum cholesterol, high-density lipoprotein cholesterol (HDLc), serum triglycerides, ALT (GPT), AST (GOT), creatinine, urea and uric acid were obtained from EL-Gomhouria Co. for Trading in Medicines, Chemicals and Medical Supplies, EL Mansoura City, Dakhaleia Governorate, Egypt.

Methods

Preparation of pre-emulsified oil

Sunflower oil was pre-emulsified on the day of use, as described by Hoogenkamp (1989 a and b) and Hammer (1992). 10 parts of hot Sunflower oil were mixed for 2 min. with one part of emulsifier Palsgaard. Then the mixture was emulsified with 8 parts of hot water for 2-3 min.

Formulation of high and low fat beef burgers with fat replacer.

Beef burger samples were formulated according to standard industry practices of the Egyptian Organization for Standardization and Quality (EOS, 2005) and the ingredients tabulated in Table (1).

Table 1. Ingredients used in preparing high and low fat beef burgers formulae with Sunflower Emulsified Oil (SEO) %

Ingredients	Treatments				
	Control	LFC	LFBB1	LFBB2	LFBB3
Beef Meat	60	67.5	67.5	69.38	71.25
Fatty Tissue	20	10	0	0	0
Sunflower Emulsified Oil (SEO)	0	0	10	7.5	5
Cold Water	5.0	5.62	5.62	5.78	6.0
Tomato Juice	3.6	4.1	4.1	4.16	4.2
Salt (NaCl)	1.5	1.7	1.7	1.73	1.78
Onion (Powder)	0.5	0.56	0.56	0.58	0.6
Garlic (Powder)	0.25	0.28	0.28	0.29	0.3
Parsley (Powder)	0.25	0.28	0.28	0.29	0.3
Spices Mixture	0.5	0.56	0.56	0.58	0.6
Corn Starch	3.0	3.4	3.4	3.47	3.56
Rusk	4.5	5.0	5.0	5.2	5.34
Sodium TryPolyPhosphate	0.3	0.33	0.33	0.34	0.35
Mono Sodium Glutamate	0.5	0.56	0.56	0.58	0.6
Sorbic Acid	0.10	0.11	0.11	0.12	0.12
Total	100	100	100	100	100

LFC= Low Fat Control; LFBB1= Low fat beef burger (10% Sunflower Emulsified Oil); LFBB2= Low fat beef burger (7.5% Sunflower Emulsified Oil); LFBB3= Low fat beef burger (5% Sunflower Emulsified Oil).

Burger formulae were formed using a petri dish to obtain round discs 9cm diameter and 1cm thickness. After preparation of each formula, the beef burger samples were

packed in polyethylene bags and stored immediately in a deep freezer at -18°C.

Chemical Analysis

Gross chemical :

Moisture, protein, fat (ether extract) , and ash contents were determined according to methods (AOAC, 2005). While total carbohydrates were estimated by the difference according to Egan *et al.,* (1981) as follow:

Total carbohydrates % = 100 - % (Moisture + protein +fat + ash).

Total Dietary Fiber (TDF)

Total Dietary Fiber (TDF) was determined according to the method described by Mayard (1970).

Physical Properties

Water Holding Capacity (WHC) and Plasticity

Water Holding Capacity (WHC) was determined according to Tsai and Ockerman (1981) by the following equations:

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

WHC (%) = 100 - free water

Also, WHC and Plasticity were measured by Grau and Hamm (1957) using the following equations:

WHC (cm^2) = Total surface area - meat film area

Plasticity (cm^2) = Meat film area (Internal area)

Cooking Characteristics

Texture Profile Analysis

Texture profile analysis (TPA) was determined using a universal testing machine model (Cometech, B type, Taiwan) as described by (Bourne, 2003).

Shrinkage

Shrinkage percentage was calculated as described by A.M.S.A (1995) as follows:

% Shrinkage = [((A− C) + (D − C)) / (A + D)] x 100

A=Raw thickness C=Cooked thickness D=raw diameter

Diameter reduction

beef burgers diameter was determined by Gök *et al.,* (2011) using the following equation:

% Diameter Reduction in = [(Uncooked diameter – Cooked diameter) / Uncooked diameter] x 100

Cooking loss after grilling

Cooking loss of beef burger was determined according to A.M.S.A (1995). It was measured after grilling beef burger samples. Cooking loss was calculated as follows:

% Cooking loss = [(Raw sample weight (g) – Cooked sample weight (g)) / Raw sample weight (g)] x 100

Cooking yield after grilling

Cooking yield of the beef burger samples was determined by measuring the weight of three burgers for each treatment/batch Gök *et al.,* (2011) and calculated weight differences for burgers before and after cooking, as follows:

% Cooking yield = [Cooked weight (g) / Raw weight (g)] x 100

Texture indices

Protein water coefficient (PWC) and Protein-water-fat coefficient (PWFC) were calculated according to Tsolaze (1972) using the following equations:

PWC = % protein / % water

PWFC = % protein / (% water + % fat)

Feder value

Feder value which is used for assessing one of the quality attributes in meat was determined according to Pearson (1970), using the following equation:

Feder value = % water / % organic non fat

Where % organic non fat = 100 – (% Moisture + % Fat + % Ash)

Organoleptic Evaluation

beef burger samples were evaluated organoleptically after grilling (at zero time) according to the method by Gök *et al.,* (2008). Sensory evaluation was carried out by ten panelists at food Industries Dept., Faculty of Agriculture, Mansoura University. A continuous scale between 1.0 and 9.0 was used for evaluation of the each attribute. Panelists were asked to evaluate the samples for color, flavour , appearance, juiciness, texture and overall acceptability. The hedonic scale was as follows: 1–3 (not acceptable); 4–5 (fairly acceptable); 6–7, good (acceptable); and 8–9, very good.

Biological Evaluation

Experimental animals

Thirty Sprague-Dawley strain male albino rats, weighing between 110-130 g were used. Rats were placed in animal Laboratory, Faculty of Medicine, Mansoura University, Egypt.

All rats were fed the control (Basal) diet for seven days. Each rat was housed individually in stainless steel wire cage under controlled condition. Diets were offered to the rats in a special non – scattering feeding cup to avoid loss of food and contamination. Tap water was provided using glass tubes projecting through wire cages

Experimental design

All rats were fed on basal diet for one week (adaptation time). Rats were divided into 6 groups, five rats in each group with similar total body weight. beef burgers were minced and mixed with basal diet (BD) which prepared according to Reeves *et al.,* (1993) as shown in Table (2). After seven days of adaptation, the rats were subjected to a feeding trial for six weeks. During the feeding period, water was provided *ad libitum* and the diets were restricted to 20 g/day.

The diet was replaced daily, while the spilled food was collected and weighed to determine total food intake. The food intake was recorded daily and the weight of the rats was recorded individually every week. Rats were divided into 6 groups and fed for 6 weeks according to the following:

Group 1 (G1) (Negative control): basal diet.

Group 2 (G2) (Positive control): high fat diet contain (20% fatty tissue).

Group 3 (G3) (Low fat control): low fat diet contain (10% fatty tissue).

Group 4 (G4): low fat diet contain (10% SEO).

Group 5 (G5): low fat diet contain (7.5% SEO).

Group 6 (G6): low fat diet contain (5% SEO).

Blood sampling

Blood samples were obtained after an overnight fast at the end of the experiment. Blood was collected from vein plexus eye into a dry clean centrifuge tube and left to clot in a water bath (37°C) at room temperature for half hour.

The blood centrifuged for 10 minutes at 3000 rpm to separate the serum, then a part of it was subjected to glucose determination and the reminder was carefully aspirated and transferred into clear fit plastic tubes and kept frozen at (-20°C) until analysis.

Biochemical Analysis of serum

Estimation of serum glucose

Blood glucose was estimated in blood serum by using a commercial kit (Spain React Company, Spain) according to the method recommended by Trinder (1969) as follow:

Concentration of serum glucose (mg/dl) = [Absorbance of Sample / Absorbance of Standard] x 100

Determination of lipids profile

a- Determination of total cholesterol

Total cholesterol was determined by enzymatic colorimetric method using kits according to Meiattini *et al.,* (1978).

b- Determination of triglycerides

Triglycerides were determined by enzymatic colorimetric method using kits according to Fossati and Prencipe (1982).

c- Determination of Lipoprotein-cholesterol

High Density Lipoprotein Cholesterol (HDL-c), Low density Lipoprotein Cholesterol (LDL-c) and Very Low Density Lipoprotein Cholesterol (VLDL-c) in serum were performed according to the method of Lopez-Virella *et al.,* (1977).

Calculation of HDL-c, LDL-c and VLDL-c were carried out by the following equations:

HDL-cholesterol (mg/dl) = [Absorbance of Sample / Absorbance of Standard] x 55

LDL-c (mg/dl) = Total cholesterol - (VLDLc + HDL-c).

VLDL-c (mg/dl) = (triglyceride / 5)

Table 2. Composition of basal diets (g/1000g)

Ingredients (g)	Groups					
	G1 NC	G2 PC	G3 LFC	G4 LFBB1	G5 LFBB2	G6 LFBB3
Corn starch	620.7	383.5	385.8	392.1	394.7	396.2
Casein (≥85%Protein)	140	92.2	89.9	83.6	81	79.5
Sucrose	100	100	100	100	100	100
Corn oil	40	25	25	25	25	25
Cellulose	50	50	50	50	50	50
Mineral formulae	35	35	35	35	35	35
Vitamin formulae	10	10	10	10	10	10
L-Cystine	1.8	1.8	1.8	1.8	1.8	1.8
Choline bitartrate	2.5	2.5	2.5	2.5	2.5	2.5
Beef burger	0	300	300	300	300	300
Total	1000	1000	1000	1000	1000	1000

NC= Negative Control (Basal diet); PC= Positive Control (20% fatty tissue); LFC= Low fat control (10% fatty tissue); LFBB1= Low fat beef burger (10% SEO); LFBB2= Low fat beef burger (7.5% SEO); LFBB3= Low fat beef burger (5% SEO).

Determination of Liver functions

Glutamic Pyruvic Transaminase (GPT) or Alanine Aminotransferase (ALT) and Glutamic Oxaloacetic Transaminase (GOT) or Aspartate aminotransferase (AST) were determined using a commercial kit according to the method described by Wallnöfer *et al.,* (1974) and Tietz (1995).

Determination of Kidney functions

Creatinine, urea and uric acid were determined using enzymatic colorimetric kit according to the method described by Tietz (1995); Young (1995 and 2001).

Statistical Analysis

Data were analyzed using SAS (2006). Differences were subjected to (LSD) least significant difference.

RESULTS AND DISCUSSION

Gross chemical composition and total dietary fiber contents in beef burger formulae

Gross chemical composition of low fat beef burger formulated with different amounts of Sunflower Emulsified Oil (SEO) are showed in Table (3). The differences in moisture, protein, ether extract, ash and carbohydrate content of low fat beef burger were statistically significant compared to the control (P≤0.01).

Results were shown in Table (3) mentioned that the beef burgers had a moisture content ranging from 59.13% - 65.86%. The highest level of moisture content was observed in prepared beef burger sample by SEO at the ratio of 10%. In addition, increased of moisture content of beef burger, is also in accordance with the work of Choi *et al.,* (2009) who reported that vegetable oil provide higher water retention and improved emulsion stability.

Table 3. Gross chemical composition and total dietary fiber contents of beef burger formulae

Treatments	Moisture M±SD	Protein (DWB) M±SD	Ether extract (DWB) M±SD	Ash (DWB) M±SD	Carbo-hydrate (DWB) M±SD	Dietary Fiber (DWB) M±SD
Ctrl.	59.13[d] ±2.42	33.37[b] ±6.34	29.78[a] ±2.41	7.76[a] ±0.93	29.09[a] ±9.67	6.03[a] ±0.38
LFC	60.18[cd] ±2.17	35.85[b] ±4.39	19.20[b] ±3.69	7.43[a] ±0.37	37.53[a] ±8.44	6.31[a] ±0.32
LFBB1	65.86[a] ±0.64	46.80[a] ±2.40	16.20[b] ±0.05	5.70[b] ±0.27	31.30[a] ±2.64	3.82[b] ±0.16
LFBB2	64.72[ab] ±0.54	47.42[a] ±1.85	11.54[c] ±0.07	5.32[b] ±0.07	35.72[a] ±1.78	3.49[bc] ±0.23
LFBB3	62.37[bc] ±2.14	45.72[a] ±3.68	10.39[c] ±0.35	5.14[b] ±0.11	38.74[a] ±3.95	3.18[c] ±0.13
Sign	**	**	**	**	NS	**

Ctrl.= Control (20% fatty tissue); LFC= Low Fat Control (10% fatty tissue); LFBB1= Low fat beef burger (10% Sunflower Emulsified Oil); LFBB2= Low fat beef burger (7.5% Sunflower Emulsified Oil); LFBB3= Low fat beef burger (5% Sunflower Emulsified Oil).; *= Significant; **= high Significant; NS= No Significant; M= Means of 3 replicates; SD= Standard Deviation; DWB= dry weight basis; Carbohydrate contents were determined by different; Means with the same letter in each column are not significantly different (p≤0.05).

Differences between protein content of beef burger samples were highly significant at (P≤0.01). The highest protein content was obtained from beef burger samples with 7.5% SEO being 47.42% (on dry weight basis). While, the lowest protein content was exhibited in control sample (33.37% on dry weight basis) followed by low fat beef burger samples (35.85% on dry weight basis) which prepared without any fat replacers.

Data tabulated in Table (3) showed a highly significant reduction at (P≤0.01) in ether extract of all low fat beef burger samples compared with the control sample, lowest values of ether extract was observed in low fat beef burger sample which contained 5% SEO. This decreases may be due to the low fat beef burger sample that formulated initially with less fat than control. Results also, indicated that ether extract of beef burger control sample was 29.78 (on dry weight basis) followed by low fat control 19.20 (on dry weight basis). While, ether extract of low fat beef burger samples ranged from 10.39% to 16.20% (on dry weight basis).

Results in Table (3) showed the content of ash in different beef burger samples. All prepared samples were lower than those of control burger samples. The content of ash ranged from 5.14 and 5.70 on dry weight basis. On the other hand, the highest ash content were observed in control sample (7.76% on dry weight basis) followed by low fat beef burger control 7.43%.

Total carbohydrate content of beef burger observed no significant differences at (P>0.05) in all beef burger samples. The lowest calculated of total carbohydrate content (29.09%) on dry weight basis was obtained from control sample, while low fat beef burger which formulated with 5% SEO recorded the highest value 38.74%.

Fiber was considered as suitable for preparation some meat products due to its water retention property, decreases cooking loss and neutral flavor enhancing . which affect product quality and characteristics (Tungland and Meyer, 2002).

Results obtained from Table (3) revealed that control burger samples had the highest dietary fiber content. As shown in the same table significant differences were observed between the control samples and low fat beef burgers formulated with different ratios of SEO. In addition the lowest dietary fiber content obtained in low fat beef burger samples containing SEO being 3.18%.

Fat replacer efficiency on physical properties of beef burger samples

Changes in Water Holding Capacity (WHC)

Water holding capacity of meat products is a very important quality attribute which has an influence on product yield, which in turn has economic implications, but is also important in terms of eating quality (Chang and Sun, 2008).

Data obtained from Table (4) revealed that addition of SEO caused a decrease in WHC comparable with high fat beef burger control. Moreover, the lowest value of WHC (-1.45% and 9.98 cm^2) was recorded for the low fat control without addition of fat replacers. While, addition of SRB with different ratio recorded the highest values of WHC.

Changes in plasticity

Plasticity of meat is a rheological parameter determining the strength necessary for destroying the structure of the material of the tested subject (Tyszkiewicz *et al.,* 2006).

Obtained results from Table (4) indicated that beef burgers as influenced by different ratio of SEO had no significant differences at (P>0.05) for the plasticity with control sample except low fat beef burger sample containing 10% SEO which had significantly plasticity when compared with other treatments.

Table 4. Changes in Physical properties and Feder value of beef burger formulae

Treatments	WHC % M±SD	WHC cm² M±SD	Plasticity cm² M±SD	PWC M±SD	PWFC M±SD	Feder value M±SD
Ctrl.	47.67ᵃ ±12.37	5.05ᶜ ±1.13	4.16ᵇ ±0.39	0.23ᶜ ±0.022	0.19ᶜ ±0.019	2.34ᵃᵇ ±0.35
LFC	-1.45ᶜ ±9.13	9.98ᵃ ±0.82	3.89ᵇ ±0.64	0.24ᶜ ±0.008	0.21ᵇ ±0.006	2.08ᵃᵇ ±0.30
LFBB1	37.37ᵃᵇ ±17.41	6.75ᵇᶜ ±1.89	5.51ᵃ ±0.86	0.24ᵇᶜ ±0.005	0.22ᵇ ±0.006	2.47ᵃ ±0.08
LFBB2	23.91ᵇ ±8.17	8.06ᵃᵇ ±0.92	4.79ᵃᵇ ±0.48	0.26ᵃᵇ ±0.004	0.24ᵃ ±0.004	2.21ᵃᵇ ±0.05
LFBB3	32.64ᵃᵇ ±0.62	6.87ᵇᶜ ±0.19	4.58ᵃᵇ ±0.55	0.28ᵃ ±0.005	0.26ᵃ ±0.004	1.97ᵇ ±0.18
Sign	**	**	NS	**	**	NS

LSD= Least Significant Difference; *= Significant; **= high Significant; M= Means of 3 replicates; SD= Standard Deviation; NS= No Significant; Means in each column were not significantly different at P≤0.05.

As shown in Table (4) the lowest value of plasticity (3.89 cm²) was observed in low fat control, while the highest value (5.51 cm²) was obtained from low fat beef burger which formulated with 10% SEO.

Changes in Texture indices [Protein-Water Coefficient (PWC) and Protein-Water-Fat Coefficient (PWFC)] of uncooked and cooked beef burger samples

Results presented in Table (4) and. It could be revealed that the lowest values of PWC and PWFC for beef burger samples being 0.23 and 0.19 were recorded with the control sample. On the other hand, the highest values were observed by the low fat beef burger with 5% SEO 0.28 and 0.26, respectively.

Furthermore, these findings observed that slight differences for PWC and PWFC of beef burgers between the control sample and the other beef burger samples. These results might be due to the increase in protein content.

Changes in Feder value

Feder value was one of the tests used for assessing the quality of meat products (Kenawi *et al.,* 2009).

According to the data presented in Table (4) it could be observed that low fat beef burger containing 5% SEO had the lowest feder value for beef burgers. While, the low fat beef burger with 10% SEO recorded the highest feder value.

Furthermore, feder values of beef burgers at zero time were less than 4. So, these products had a good quality according to Pearson (1970).

Changes in shrinkage and diameter reduction after grilling

Shrinkage is one of the important quality attributes measurements of meat and meat products. Percent of shrinkage in beef burgers shown in Table (5). The beef burger control had differences higher significant at (P≤0.01) in shrinkage being 16.33% and diameter reduction 17.04%, than others. Also, Results indicated that all added SEO as fat replacers improved the shrinkage values of low-fat beef burgers in compared with control sample.

Changes in cooking loss % and cooking yield %

The percent of cooking loss and cooking yield is presented in Table (5). There was a high significantly differences at (P≤0.01) in cooking loss between the beef burger sample control and the others. Also, beef burger control had highest cooking loss (25.27%). In contrast, the lowest percent of cooking loss (18.84%) was observed for beef burger sample formulated with 10% fatty tissue without fat replacer.

Cooking yield results are the most important test for the meat industry to predict the behavior of the products during cooking due to non-meat ingredients or other factors (Pietrasik and Lin-Chan, 2002). As shown in Table (5) cooking yields of all beef burger samples were a higher significantly increase than beef burger control.

Table 5. Changes in shrinkage, diameter reduction, cooking loss and cooking yield after grilling

Treatments	% Shrinkage M±SD	% Diameter reduction M±SD	% Cooking loss M±SD	% Cooking yield M±SD
Ctrl.	16.33ᵃ ±0.58	17.04ᵃ ±0.64	25.27ᵃ ±0.23	74.73ᵉ ±0.23
LFC	12.67ᵇ ±2.89	12.96ᵇ ±3.21	18.84ᵉ ±0.28	81.16ᵃ ±0.28
LFBB1	11.00ᵇ ±0.00	11.11ᵇ ±0.00	23.03ᵇ ±0.20	76.97ᵈ ±0.20
LFBB2	11.00ᵇ ±0.00	11.11ᵇ ±0.00	19.92ᶜ ±0.10	80.08ᶜ ±0.10
LFBB3	11.00ᵇ ±0.00	11.11ᵇ ±0.00	19.48ᵈ ±0.08	80.52ᵇ ±0.08
Sign	**	**	**	**

LSD= Least Significant Difference; *= Significant; **= high Significant; M= Means of 3 replicates; SD= Standard Deviation; NS= No Significant; Means with the same letter in each column are not significantly different at P≤0.05.

Changes in Texture Profile Analysis (TPA) of cooked beef burger samples

Texture is one important parameters in meat products. Hardness (the "first bite"), springiness (elasticity), and chewiness (hardness x cohesiveness x springiness) are some of the parameters of interest for evaluating in new meat formulations. Many factors effect on the tenderness or textural properties of a product such as fat level, storage conditions and temperature of storage (Laroia, 1994).

Significant differences at (P≤0.01) were observed in the texture profile analysis (for firmness, cohesiveness, gumminess, chewiness, springiness and resilience) occurred with addition of SEO to burger samples (Table, 6). Generally, low fat beef burgers formulated with 7.5% SEO was less in firmness, cohesiveness, gumminess, chewiness, springiness and resilience (10.32, 0.53, 5.48, 2.92, 0.57 and 0.31, respectively than high fat control (19.05, 0.67, 12.74, 7.93, 0.62 and 0.51), respectively.

Addition of SEO caused a decrease in firmness in the low fat burger samples which could be due to that SEO reducing the bind between meat particles. These results agreed with Crehan *et al.,* (2000).

Using SEO as fat replacer gave significantly values for gumminess of low fat beef burger samples being 7.20, 5.48, 7.79, and 12.74 for treated burger with 10, 7.5, 2.5% SEO and the control, respectively.

Table 6. Changes in Texture Profile Analysis (TPA) of cooked beef burger samples

Treatments	Firmness M±SD	Coh M±SD	Gum M±SD	Chewiness M±SD	Springiness M±SD	Resilience M±SD
Ctrl.	19.05[a] ±2.39	0.67[ab] ±0.05	12.74[a] ±2.49	7.93[a] ±1.60	0.62[ab] ±0.004	0.51[ab] ±0.03
LFC	17.51[ab] ±2.50	0.65[ab] ±0.02	11.36[ab] ±1.89	6.56[a] ±1.72	0.57[b] ±0.06	0.46[abc] ±0.04
LFBB1	10.32[c] ±1.07	0.70[a] ±0.01	7.20[bc] ±0.90	5.25[ab] ±0.28	0.73[a] ±0.05	0.62[a] ±0.04
LFBB2	10.32[c] ±0.45	0.53[c] ±0.05	5.48[c] ±0.75	2.92[b] ±0.35	0.57[b] ±0.04	0.31[c] ±0.12
LFBB3	12.87[bc] ±3.92	0.60[bc] ±0.004	7.79[bc] ±2.42	4.75[ab] ±1.81	0.60[b] ±0.04	0.42[bc] ±0.06
Sign	*	*	*	*	*	*

Cho= Cohesiveness; Gum= Gumminess*= Significant; **= high Significant; NS= No Significant; LSD= Least Significant Difference; M= Means of 3 replicates; SD= Standard Deviation Means with the same letter in each column are not significantly different at P≤0.05.

Organoleptic evaluation of cooked beef burger samples

According to Gök *et al.,* (2008), palatability of foods is measured by different sensory properties, such as color, flavor, appearance, juiciness, texture and express their overall acceptability. Data presented in Table (7) revealed that all burger samples were acceptable by the panelists in all sensorial properties. Generally, from results in the same Table, it could be observed that all Parameters had no significant differences for burger samples.

Table 7. Organoleptic Evaluation of cooked beef burger samples

Treatments	Color M±SD	Flavor M±SD	App M±SD	Ju M±SD	Tex M±SD	OA M±SD	Total M±SD
Ctrl.	6.15[a] ±1.20	7.25[a] ±1.90	6.80[a] ±1.49	6.15[a] ±1.86	7.55[a] ±1.30	7.65[a] ±1.45	41.55[a] ±5.13
LFC	7.10[a] ±1.20	7.30[a] ±0.82	6.85[a] ±1.06	6.45[a] ±1.54	6.65[a] ±1.38	7.40[ab] ±0.97	41.75[a] ±5.14
LFBB1	6.75[a] ±1.36	6.20[a] ±1.03	6.40[a] ±1.43	6.50[a] ±1.18	6.80[a] ±1.75	7.30[ab] ±0.95	39.95[a] ±5.73
LFBB2	6.90[a] ±1.45	6.55[a] ±1.61	6.75[a] ±1.18	5.90[a] ±1.97	6.80[a] ±1.48	7.00[ab] ±1.33	39.90[a] ±7.71
LFBB3	6.90[a] ±1.45	6.25[a] ±1.44	6.50[a] ±1.43	5.90[a] ±1.52	6.60[a] ±1.51	6.40[b] ±1.51	38.55[a] ±6.39
Sign	NS	NS	NS	NS	NS	NS	NS

App= Appearance; OA= Overall Acceptability; *= Significant; **= high Significant; NS= No Significant; M= Means of 10 replicates; Ju= Juiciness; Tex= Texture; LSD= Least Significant Difference; SD= Standard Deviation; Means with the same letter in each column are not significantly different at P≤0.05.

Biological Evaluation

Glucose and lipid profile of rats blood serum fed on different diets of burger formulae

Glucose of blood serum

The results of blood glucose and lipid profile were summarized in Table (8). The blood glucose in group 2 (positive control) was high significant at (P≤0.01) when compared with group 1 (negative control) and all groups fed on low fat beef burgers formulated with SEO. But it was no significant affect as compared with group 3 (low fat control).

Moreover, results showed that blood glucose in all fat replacers groups ranged from 84.87 mg/dl to 90.33 mg/dl for groups 6 and 4, respectively. It was 80.03 mg/dl for the negative control group, but the positive control group recorded the highly blood glucose value 106.53 mg/dl.

Total cholesterol and triglycerides of blood serum

Group 2 (positive control) which fed on high fat diet (Table, 8) showed significant increase at (P≤0.01) in total cholesterol when compared with all groups including basal diet (negative control group). The lowest cholesterol value being 78.47 mg/dl was observed in group 6 which fed on diet formulated with 5% SEO. On contrast, the highest value of total cholesterol was 98.37 mg/dl for group 2 followed by group 3 which fed on low fat beef burgers prepared with 10% fatty tissue without fat replacer.

Table 8. Glucose and lipid profile of rats blood serum fed on different diets of beef burger formulae

Groups	Glucose mg/dl M±SD	TC mg/dl M±SD	TG mg/dl M±SD	HDL-C mg/dl M±SD	LDL-C mg/dl M±SD	VLDL-C mg/dl M±SD
1	80.03[c] ±3.37	72.97[d] ±3.70	110.77[c] ±4.92	33.00[a] ±1.67	17.81[c] ±3.83	22.15[c] ±0.98
2	106.53[a] ±4.70	98.37[a] ±6.36	224.50[a] ±9.17	17.80[d] ±1.74	35.67[a] ±7.02	44.90[a] ±1.83
3	100.57[a] ±1.66	89.27[b] ±5.44	214.03[a] ±26.39	19.37[cd] ±0.70	27.09[b] ±4.38	42.81[a] ±5.28
4	90.33[b] ±6.13	85.57[bc] ±4.65	185.47[b] ±7.52	22.27[c] ±2.30	26.21[b] ±4.08	37.09[b] ±1.50
5	88.87[b] ±1.46	80.83[cd] ±3.13	178.03[b] ±8.29	28.60[b] ±2.27	16.63[c] ±4.97	35.61[b] ±1.66
6	84.87[bc] ±3.30	78.47[cd] ±1.86	174.73[b] ±5.14	33.53[a] ±2.21	9.99[c] ±2.93	34.95[b] ±1.03
Sign	**	**	**	**	**	**

*= Significant; **= high Significant; NS= No Significant; M= Means of 3 replicates; SD= Standard Deviation; LSD= Least Significant Difference; Means with the same letter in each column are not significantly different at P≤0.05.

Also, triglycerides were increased in the positive control group and the low fat control group ranged from 224.50 and 214.03 mg/dl comparing with the other groups. Furthermore, data obtained from Table (8) showed a high significant affect at (P≤0.01) between positive control group and all groups containing fat replacers.

High Density Lipoprotein (HDL) - Cholesterol, low density Lipoprotein (LDL) - Cholesterol and Very Low Density Lipoprotein (VLDL) - Cholesterol of rats blood serum fed on different diets of beef burger formulae

Results in Table (8) presented a highly significant difference at (P≤0.01) in HDL-c value between the positive group (G2) and all other groups.

High Density Lipoprotein (HDL) values could be arranged descendingly as follows: Group 6 > Group 1 > Group 5 > Group 4 > Group 3 > Group 2 being 33.53, 33.00, 28.60, 22.27, 19.37 and 17.80 mg/dl. There was highly significant difference at (P≤0.01) in LDL-cholesterol content between the positive group (G2) and all other groups. The positive control recorded the highest value of LDL-cholesterol comparing with low fat beef burgers which contained fat replacers.

Data showed that positive control had the highest VLDL-cholesterol being 44.90 mg/dl followed by low fat control group (42.81 mg/dl). Furthermore, there was a high significant differences in VLDL-cholesterol content between all groups and the positive control group (22.15 – 44.90 mg/dl).

Liver functions of rats fed on different diets of beef burger formulae

Determination of GPT and GOT known as liver function tests (LFTs) and is used in monitoring liver damage cell (Huang *et al.,* 2006; Choudhury *et al.,* 2011; Hsueh *et al.,* 2011).

From data listed in Table (9) it could be noticed that after 6 weeks feeding, there was a high significant increase at (P≤0.01) in GPT (ALT) levels. And data illustrated that the lowest GPT obtained from group 1, while group 2 (positive control) recorded the highest level of GPT.

Data presented in the same Table showed the effect of beef burgers prepared with different levels of fat replacers (SEO) on GOT (AST) of rats after feeding

for 6 weeks. There was a high significant increase in GOT between the positive control group and all other groups of rats.

Moreover, results revealed that high fat diet group (positive control) recorded the highest value of GOT enzyme, while the lowest value obtained from rats groups feeding on diets containing 5% SEO.

Kidney functions of rats fed on different diets of beef burger formulae

serum creatinine concentration was widely interpreted as a measurement of the glomerular filtration rats (GFR) and used as renal function index in clinical practice (Perrone *et al.,* 1992).

At the end of experimental period for creatinine, (Table, 9). It could be observed that a high significant differences at (P≤0.01) between all rats groups comparing to the positive control group. Table (9) showed that negative control recorded 0.53 mg/dl for creatinine. Moreover, the lowest value of creatinine (0.66 mg/dl) obtained from rats group 6 which fed on diet containing 5% SEO. On contrary, the positive control group recorded the highest value of creatinine (1.19 mg/dl).

The level of urea in plasma is markedly affected by renal perfusion, the protein content of the diet, and the level of protein catabolism. A high-protein diet, fever, major illness, or stress may increase urea levels (Yan *et al.,* 1999).

After six weeks feeding on different diets of beef burger there was a high significant increase at (P≤0.01) in urea levels of the positive control when compared with other groups including the negative control except low fat control group which had no significant.

Table (9) showed that lowest value of urea (50.37 mg/dl) obtained from group 6 which fed on diet containing 5% SEO. On the other hand, high fat and low fat control (group 2 and 3) recorded the highest values of urea (66.37 and 62.97 mg/dl respectively).

In humans, uric acid is the final breakdown product of purine metabolism. There are three major causes for elevated levels of uric acid: gout, renal disease, and a higher rate of nucleic acid breakdown. High levels of uric acid are also found secondary to a variety of diseases, such as glycogen storage disease (Yan *et al.,* 1999).

Table 9. Glutamic Pyruvic Transaminase (GPT), Glutamic Oxaloacetic Transaminase (GOT), Creatinine, Urea and Uric acid of rat fed with different diets of beef burger

Groups	GPT U/L M±SD	GOT U/L M±SD	Creatinine mg/dl M±SD	Urea mg/dl M±SD	Uric acid mg/dl M±SD
1	26.17[b] ±11.40	27.63[c] ±15.59	0.53[c] ±0.05	44.07[d] ±3.76	2.05[e] ±0.11
2	88.17[a] ±10.66	115.60[a] ±19.71	1.19[a] ±0.18	66.37[a] ±3.10	3.64[a] ±0.13
3	82.33[a] ±13.61	91.83[ab] ±3.84	1.04[a] ±0.08	62.97[a] ±2.60	3.23[b] ±0.08
4	83.93[a] ±11.60	73.67[b] ±18.05	0.76[b] ±0.05	56.17[b] ±1.91	2.93[c] ±0.08
5	79.97[a] ±7.31	67.00[b] ±12.11	0.71[b] ±0.03	55.03[bc] ±4.43	2.55[d] ±0.19
6	80.67[a] ±9.25	62.50[b] ±28.42	0.66[bc] ±0.03	50.37[c] ±2.22	2.13[e] ±0.11
Sign	**	**	**	**	**

ALT= Alanine Aminotransferase; GPT= Glutamic Pyruvic Transaminase; AST= Aspartate aminotransferase; GOT Glutamic Oxaloacetic Transaminase; LSD= Least Significant Difference; *= Significant; **= high Significant; M= Means of 3 replicates; NS= No Significant; SD= Standard Deviation; Means with the same letter in each column are not significantly different at P≤0.05.

Finally, the results obtained from Table (9) illustrated that uric acid of the positive control group had a high significant increase at (P≤0.01) when compared with all other rats groups. Furthermore, the highest value of uric acid (3.64 mg/dl) was obtained from rats group ٢ which fed on diet containing 20% fatty tissue. While, rats group 6 had the lowest level (2.13 mg/dl) followed by rats group 5 (2.55 mg/dl).

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تاثير استخدام مستحلب زيت عباد الشمس علي الصفات الفيزيائية والكيميائية والحيوية لبرجر اللحم منخفض الدهن

ياسر إسماعيل الشربيني ، أبوبكر محمد حسن ، منى محمود خليل و رانيا إبراهيم الجمال
قسم الصناعات الغذائية – كلية الزراعة – جامعة المنصورة

استخدم مستحلب زيت عباد الشمس كبديل للدهن في إعداد برجر اللحم منخفض الدهن بنسب 10، 7.5 و5% تم إجراء تقييم للخواص الكيميائية والفيزيائية وخواص الطبخ ومنها قياسات القوام، الانكماش وفقد الطبخ بالإضافة إلى التقييم البيولوجي. أشارت النتائج إلى أن إضافة مستحلب زيت عباد الشمس أدت إلى زيادة محتوى الرطوبة، البروتين والكربوهيدرات وإنخفاض كمية الدهون، الرماد، الانكماش وفقد الطبخ بالمقارنة مع عينة برجر اللحم الكنترول. أظهر التحليل الإحصائي أن هناك فروق معنوية في قياسات قوام برجر اللحم المعد باستخدام مستحلب زيت عباد الشمس. كانت مستويات الكوليسترول الكلي، الجليسريدات الثلاثية، الليبوبروتينات المرتفعة والمنخفضة الكثافة 78.47، 174.73، 33.53 و 9.99 مجم/ديسلتر بالمقارنة مع مجموعة الكنترول الموجبة 98.37، 224.50، 17.80 و35.67 على التوالي. يستنتج من هذا البحث أن مستحلب زيت عباد الشمس له تأثير في تحسين الخواص الفيزيائية والكيميائية والخواص الوظيفية لبرجر اللحم وكان له تأثير خافض لدهون الدم في فئران التجارب.

الكلمات الدالة : برجر اللحم منخفض الدهن- بديل للدهن ـ مستحلب زيت عباد الشمس