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CHEMICAL, PHYSICAL AND BIOLOGICAL CHARACTERISTICS OF LOW FAT BEEF BURGER WITH MALTODEXTRIN

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ABSTRACT

Maltodextrin used as fat replacers in preparing low fat beef burger was added by substitution of fat at the ratio of 2.5, 5 and 7.5%. Gross chemical composition, physical properties, cooking characteristics namely Texture Profile Analysis (TPA), cooking loss, yield and Biological evaluation were determined. Results indicated that addition of maltodextrin increase the amount of moisture, carbohydrates and dietary fiber and decrease the amount of fat in compare with control beef burger sample. Statistical analysis for physical properties indicated that there were a significant differences in both shrinkage and diameter reduction, while no differences were observed in TPA for beef burger formulas prepared with maltodextrin. Prepared beef burger decreased of total cholesterol (TC), up to 66.20 mg/dl and Triglycerides (TG) to 91.37 mg/dl. While, LDL-C and HDL-C reached 39.97 mg/dl and 6.36 mg/dl respectively compared with both control samples 33.00, 17.80 and 17.81, 35.67 mg/dl respectively. So this research suggests that maltodextrin is effective in improving physical, chemical and functional properties of beef burger and also, had a hypolipidemic effect on experimental rats.
Keywords: low fat beef burger, fat replacer, maltodextrin

INTRODUCTION

Meat is an essential component of healthy and well balanced diet owing to its properties as a source of high-quality protein, high-available iron, essential fatty acids and B-group vitamins (Biesalski, 2005). Fat also plays important role in meat product processing, stabilizing meat emulsions, providing flavor, juiciness and desirable mouth feel (Choi *et al.,* 2010 and Vural *et al.,* 2004).

In recent years, many consumers have limited their dietary intake of fat and calories due to diet and health concerns. Consumer interest in reducing dietary fat and calorie intake has encouraged meat technologists to develop low-fat meat product formulations having good economical value and desirable palatability (Candogan and Kolsarici, 2003).

However, recent studies have established relationship between meat consumption and increased risk of suffering serious health disorders such as colorectal cancer and coronary-heart diseases (CHD) (Ferguson, 2010). While, (Seidell, 1998) observed that dietary fat has an effect on weight gain and the development of obesity that is larger than would be expected on the basis of fat's energy value. Reduction of fat in meat products and the substitution of animal fat with vegetable oils and non-meat ingredients such as dietary fiber, isolated soy protein, carrageenan, and konjac flour should result in healthier products.

Fat replacers used in reformulations of meat ingredients namely gums, inulin, maltodextrins, oatrim and olestra while, starches are used as carbohydrate-based fat replacers in meat/poultry products (Tokusoglu and Unal, 2003).

Maltodextrins are nonsweet, nutritive mixtures of saccharide polymers of varying chain lengths. They are produced by partial hydrolysis of starch obtained from corn or potato starch. The average molecular weight and degree of hydrolysis of maltodextrins varies up to a dextrose equivalence (DE) of 20. Dextrose equivalence is a measure of the reducing sugar content, expressed as glucose. Molecular weight and DE determine maltodextrin functional properties, such as viscosity/bodying ability and browning ability. Maltodextrins are used to build solids and viscosity, bind/control water, and contribute smooth mouth feel in fat replacing systems for table spreads, margarine, imitation sour cream, salad dressings, baked goods, frostings, fillings, sauces, processed meat and frozen desserts (Akoh, 1998).

So, this research was aimed to evaluate the effect of addition various amounts of maltodextrin as fat replacers on physical, chemical and biological characteristics of low fat beef burger.

MATERIALS AND METHODS

Materials

Meat and Fat

Raw meat and beef back fat were obtained from top round cut of beef carcasses, and were purchased from butcher's shop at Belkas, Dakahlia, 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).

Fat replacers

Corn maltodextrin 20-dextrose equivalent (DE) was obtained from National Co. for Maize Products, 10th of Ramadan City, Egypt.

Spices mixture

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

Other additives

Salt, onion, garlic, parsley, corn starch and rusk were purchased from local market of EL Mansoura city, 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, Egypt.

Experimental animals

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

6. 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, Egypt.

Methods

Formulation of high and low fat beef burgers with maltodextrin

Beef burger samples were formulated according to standard industry practices of the Egyptian Organization for Standardization and Quality **(EOS, No. 1688/2005)** and the ingredients tabulated in Table (1). Burger formulas were made using a petri dish to obtain round discs 9cm diameter and 1cm thickness.

Table (1): Ingredients used in processing high and low fat beef burgers with maltodextrin %

Ingredients	Treatments				
	HFC	LFC	LFBB1	LFBB2	LFBB3
Beef	60	67.5	65.6	65.6	65.6
Beef Back Fat	20	10	10	7.5	5
Maltodextrin	-	-	2.5	5	7.5
Cold Water	5	5.62	5.5	5.5	5.5
Tomato Juice	3.6	4.1	3.94	3.94	3.94
Salt, NaCl	1.5	1.7	1.64	1.64	1.64
Onion	0.5	0.56	0.55	0.55	0.55
Garlic	0.25	0.28	0.27	0.27	0.27
Parsley	0.25	0.28	0.27	0.27	0.27
Spices Mixture	0.5	0.56	0.55	0.55	0.55
Corn Starch	3	3.4	3.28	3.28	3.28
Rusk	4.5	5	4.92	4.92	4.92
Sodium TryPolyPhosphate	0.3	0.33	0.32	0.32	0.32
Mono Sodium Glutamate	0.5	0.56	0.55	0.55	0.55
Sorbic Acid	0.1	0.11	0.11	0.11	0.11
Total	**100**	**100**	**100**	**100**	**100**

HFC= High fat control (20% fat); LFC= Low fat control (10% fat); LFBB1= Low fat beef burger (10% fat + 2.5% maltodextrin); LFBB2= Low fat beef burger (7.5% fat + 5% maltodextrin); LFBB3= Low fat beef burger (5% fat + 7.5% maltodextrin).

Gross chemical composition

Moisture, protein, fat (ether extractable), ash content were determined according to methods described in (AOAC, 2005).While total carbohydrates were estimated by difference according to (Egan *et al.,* 1981) as follow:

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

Total dietary fiber (TDF)

Total dietary fiber was determined according to the method described by (Mayard, 1970).

pH value

The pH values for beef burger were determined using a calibrated pH meter (ICM 41150 pH meter) according to the procedure of (Turhan *et al.,* 2005).

Physical properties and feder value

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)

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 calculated according to (Pearson, 1970) using the following equation:

Feder value = % water / % organic non fat

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

Cooking characteristics

Texture Profile Analysis

Texture was determined in Food Technology Research. Institute, Agricultural Research Center Giza- Egypt, by a universal testing machine (Cometech, B type, Taiwan) provided with software. An Aluminum 25 mm diameter cylindrical probe was used in a “Texture Profile Analysis” (TPA) double compression test to penetrate to 50% depth, at 1 mm/s speed test. Firmness (N), gumminess (N), chewiness (N), cohesiveness (N), springiness and resilience were calculated from the TPA graphic. Both, springiness and resilience, give information about the after stress recovery capacity. But, while the former refers to retarded recovery, the latter concerns instantaneous recovery (immediately after the first compression, while the probe goes up) (Bourne, 2003).

Shrinkage

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

% Shrinkage = [(Raw thickness – Cooked thickness) + (Raw diameter – Cooked diameter) / (Raw thickness + Raw diameter)] x 100

Diameter reduction

Changes in beef burgers diameter was calculated by (Pinero *et al.,* 2008 and Gök *et al.,* 2011) using the following equation:

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

Cooking loss

Cooking loss of the beef burger was calculated according to (A.M.S.A, 1995) using the following equation:

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

Cooking yield

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

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

Organoleptic evaluation

Grilled beef burger samples were evaluated organoleptically after grilling (at zero time) according to the method of (Gök *et al.,* 2008). Sensory evaluation was carried out by ten panelists. Panel members were either staff members or post-graduate students of the Food Industries Department, Faculty of Agriculture, Mansoura University. A continuous scale between 1.0 and 9.0 was used for the evaluation of the each attribute. Panelists were asked to evaluate the samples for color, flavor, 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

Rat Diet Preparation and Feeding Protocol

The rats were placed in individual cages and distributed into eleven groups. The frozen raw beef burgers were manually cut into small sizes 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 *adlibitum* 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 scheme:

Group 1 (Negative control): fed on basal diet.
Group 2 (Positive control): fed on high fat diet (20% fat).
Group 3 (Low fat control): fed on low fat diet (10% fat).
Group 4: fed on low fat diet (10% fat + 2.5 maltodextrin).
Group 5: fed on low fat diet (7.5% fat + 5 maltodextrin).
Group 6: fed on low fat diet (5% fat + 7.5 maltodextrin).

Table (2): Composition of basal, high fat and burger 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	391.2	392.2	393.9
Casein (≥85% Protein)	140	92.2	89.9	84.5	83.5	81.8
Sucrose	100	100	100	100	100	100
Corn oil	40	25	25	25	25	25
Cellulose	50	50	50	50	50	50
Mineral mix	35	35	35	35	35	35
Vitamin mix	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% fat); LFC= Low fat control (10% fat); LFBB1= Low fat beef burger (10% fat + 2.5% maltodextrin); LFBB2= Low fat beef burger (7.5% fat + 5% maltodextrin); LFBB3= Low fat beef burger (5% fat + 7.5% maltodextrin).

Blood sampling

Blood samples were obtained after an overnight fast at the end of the experiment. Blood collected from vein plexus eye and put in dry clean centrifuged for ten minutes at 3000 rpm to separate the serum. Also, blood samples were collected in tubes containing EDTA (ethylenediaminetetraacetic acid) as anticoagulant to measure hemoglobin.

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).

Determination of lipids profile

Determination of total cholesterol

The cholesterol was determined using enzymatic colorimetric kit by the method described by (Meiattini *et al.,* 1978).

Determination of triglycerides

Triglycerides were determined using enzymatic colorimetric kit by the method described by (Fossati and prencipe, 1982).

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 LDL-c and VLDL-c were carried out by the following equations:

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

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

Determination of Enzymes

Enzymes 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 (Tietz, 1995 and Wallnöfer *et al.,* 1974).

Determination of creatinine, urea and uric acid

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

Statistical Analysis

Data obtained were analyzed using one-way analysis of variance. All statistical analysis were performed according to SAS (2006).

RESULTS AND DISCUSSIONS

Gross chemical composition, pH values and total dietary fiber contents of raw beef burgers (% on dry weight basis)

Gross chemical composition, pH values and total dietary fiber contents of raw beef burgers with different ratios from maltodextrin were tabulated in Table (3). Results showed that there were a high significant differences at P<0.01 in moisture, protein, ether extract fat, ash and pH value in all low fat burger samples compared with control sample. While, no significant differences at p>0.05 in carbohydrates except low fat beef burger formula containing 7.5% maltodextrin were observed.

Table (3): Gross chemical composition, pH value and total dietary fiber contents in beef burger formulas

Treatments	Moisture M±SD	Protein (DWB) M±SD	Fat (DWB) M±SD	Ash (DWB) M±SD	Carbohydrate (DWB) M±SD	pH M±SD	Dietary Fiber (DWB) M±SD
HFC	59.13^{b} ±2.42	33.37^{b} ±6.34	29.78^{a} ±2.41	7.76^{a} ±0.93	29.09^{a} ±9.67	6.51^{a} ±0.05	6.03^{b} ±0.38
LFC	60.18^{b} ±2.17	35.85^{b} ±4.39	19.20^{b} ±3.69	7.43^{ab} ±0.37	37.53^{a} ±8.44	6.39^{b} ±0.03	6.31^{ab} ±0.32
LFBB1	64.48^{a} ±1.24	44.33^{a} ±2.19	16.99^{bc} ±0.22	6.54^{bc} ±0.13	32.14^{a} ±2.53	5.89^{c} ±0.03	6.34^{ab} ±0.19
LFBB2	65.27^{a} ±0.74	46.17^{a} ±1.92	15.70^{bc} ±0.11	6.24^{c} ±0.41	31.90^{a} ±2.39	5.73^{d} ±0.04	6.44^{ab} ±0.22
LFBB3	66.35^{a} ±0.12	49.01^{a} ±0.45	14.36^{c} ±0.04	5.90^{c} ±0.15	30.73^{a} ±0.26	5.58^{e} ±0.05	6.77^{a} ±0.11
Sign	**	**	**	**	NS	**	NS

HFC= High fat control (20% fat); LFC= Low fat control (10% fat); LFBB1= Low fat beef burger (10% fat + 2.5% maltodextrin); LFBB2= Low fat beef burger (7.5% fat + 5% maltodextrin); LFBB3= Low fat beef burger (5% fat + 7.5% maltodextrin); *= 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).

The highest levels of moisture content were observed in prepared beef burger samples with maltodextrin 2.5, 5 and 7.5% being 64.48, 65.27 and 66.35% respectively. This observation was agreed with (Crehan, 2000) who found that the uncooked reduced-fat frankfurters had a moisture content ranging from 70.8 to 80.1% which was higher than the high-fat control.

From the same results, it could be mentioned that the lowest value of protein content of raw beef burgers being 33.37% in high fat control (HFC). On the other hand, low fat beef burger formula with 5% beef back fat and 7.5% maltodextrin had the highest values of protein content (49.01%).

Addition of maltodextrin caused an observed increase in moisture, protein, dietary fiber and decrease pH, ash and fat values.

Effect of maltodextrin on physical properties and feder value

Data in Table (4) showed the physical properties of beef burgers namely texture index (WHC, PWC and PWFC) and feder value. The water holding capacity (WHC) 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).

Table (4): Effect of maltodextrin on Physical properties and feder value of beef burger formula

Treatments	WHC % M±SD	WHC cm^2 M±SD	Plasticity cm^2 M±SD	PWC M±SD	PWFC M±SD	Feder value M±SD
HFC	47.67^{a} ±12.37	5.05^{c} ±1.13	4.16^{a} ±0.39	0.23^{b} ±0.022	0.19^{c} ±0.019	2.34^{a} ±0.35
LFC	-1.45^{c} ±9.13	9.98^{a} ±0.82	3.89^{a} ±0.64	0.24^{ab} ±0.008	0.21^{bc} ±0.006	2.08^{a} ±0.30
LFBB1	16.65^{bc} ±18.00	8.81^{ab} ±2.04	4.46^{a} ±1.26	0.24^{ab} ±0.002	0.22^{ab} ±0.001	2.38^{a} ±0.14
LFBB2	27.03^{ab} ±4.59	7.80^{ab} ±0.57	3.91^{a} ±0.93	0.25^{ab} ±0.003	0.23^{a} ±0.003	2.41^{a} ±0.09
LFBB3	37.62^{ab} ±11.19	6.77^{bc} ±1.21	4.29^{a} ±0.24	0.25^{ab} ±0.001	0.23^{a} ±0.001	2.47^{a} ±0.01
Sign	**	**	NS	NS	**	NS

WHC= Water Holding Capacity; PWC= Protein-Water Coefficient; PWFC= Protein-Water-Fat Coefficient; HFC= High fat control (20% fat); LFC= Low fat control (10% fat); LFBB1= Low fat beef burger (10% fat + 2.5% maltodextrin); LFBB2= Low fat beef burger (7.5% fat + 5% maltodextrin); LFBB3= Low fat beef burger (5% fat + 7.5% maltodextrin); *= Significant; **= high Significant; NS= No Significant; M= Means of 3 replicates; SD= Standard Deviation; Means with the same letter in each column are not significantly different (p≤0.05).

Obtained results from Table (4) revealed that the incorporation of maltodextrin to beef burger formulas caused a high significantly differences at $p<0.01$ increase in water holding capacity (WHC) value when compared with control. This result is probably due to its ability to absorb large amounts of

water. Similarly, (Troy *et al.* 1999) found that low fat beef burger had a significantly higher (P<0.05) WHC values than those of full-fat control. This low value is probably due to the fact that the high-fat control, being high in fat and low in protein.

According to the data presented in Table (4) it could be observed that beef burgers formula had no significant differences at P>0.05 for the plasticity, PWC and feder value when compared with control sample.

In addition, results indicated that a highly significant differences (P<0.01) for PWFC of raw beef burgers between control sample and all low fat beef burgers formulas, these results might be due to the increase amount in protein contents. While, no significant differences were observed between the control sample and low fat beef burgers (LFC). Also, feder values of raw beef burger samples were less than 4. So, from obtained results showed that prepared beef burger formula are in good quality according to (pearson, 1970).

Cooking characteristics

Texture Profile Analysis (TPA)

Results in Table (5) showed the different Texture Profile Analysis (TPA) namely firmness, cohesiveness, gumminess, chewiness, springiness and resilience. No significant differences at P>0.05 were observed in different TPA parameters with maltodextrin. Data in Table (5) showed that low fat beef burger control (10%fat) was less cohesiveness, gumminess, chewiness, springiness and resilience compared with other samples. While, low fat beef burger formulas containing 7.5% maltodextrin recorded the lowest firmness. Moreover, addition of maltodextrin caused a slightly decrease in firmness in the low fat burgers formulas which could be attributed to the effect of maltodextrin in reducing the bind between meat particles. These results agreed with (Crehan *et al.,* 2000).

Table (5): Texture Profile Analysis of different burger formulas.

Treatments	Firmness	Coh	Gum	Che	Spr	Resilience
	M±SD	M±SD	M±SD	M±SD	M±SD	M±SD
HFC	**19.05**[a] ±2.39	**0.67**[a] ±0.05	**12.74**[a] ±2.49	**7.93**[a] ±1.60	**0.62**[a] ±0.004	**0.51**[a] ±0.03
LFC	**17.51**[a] ±2.50	**0.65**[a] ±0.02	**11.36**[a] ±1.89	**6.56**[a] ±1.72	**0.57**[a] ±0.06	**0.46**[a] ±0.04
LFBB1	**18.19**[a] ±2.01	**0.79**[a] ±0.12	**14.29**[a] ±0.61	**10.48**[a] ±3.14	**0.73**[a] ±0.19	**0.59**[a] ±0.19
LFBB2	**16.65**[a] ±0.45	**0.82**[a] ±0.03	**13.66**[a] ±0.17	**10.65**[a] ±0.40	**0.78**[a] ±0.04	**0.66**[a] ±0.02
LFBB3	**16.53**[a] ±2.21	**0.77**[a] ±0.09	**12.54**[a] ±0.22	**9.84**[a] ±0.27	**0.79**[a] ±0.04	**0.64**[a] ±0.02
Sign	NS	NS	NS	NS	NS	NS

Coh= Cohesiveness; Gum= Gumminess; Che= Chewiness; Spr= Springiness; HFC= High fat control (20% fat); LFC= Low fat control (10% fat); LFBB1= Low fat beef burger (10% fat + 2.5% maltodextrin); LFBB2= Low fat beef burger (7.5% fat + 5% maltodextrin); LFBB3= Low fat beef burger (5% fat + 7.5% maltodextrin); *= Significant; **= high Significant; NS= No Significant; M= Means of 3 replicates; SD= Standard Deviation; Means with the same letter in each column are not significantly different (p≤0.05).

Changes in shrinkage, diameter reduction, cooking loss and cooking yield of beef burger formulas.

Shrinkage is one of the important quality attributes measurements of meat and meat products. Percent of shrinkage in beef burgers weas shown in Table (6). Significant increase in shrinkage and diameter reduction % at p≤0.05 in all beef burger formula was observed. (Troy *et al.,* 1999) showed that all treatments which prepared with tapioca starch, carrageenan, oat fiber, pectin, whey protein and a commercial mixture of carrageenan and locust bean gum as fat replacers had a reduction in diameter with the full-fat control shrinkage due to the high loss in fat and moisture during cooking.

The percent of cooking loss and cooking yield is presented in Table (6). There was a high significant differences (P<0.01) between beef burger control and all low fat beef burger formulas.

The high fat beef burger control had highest values of shrinkage, diameter reduction and cooking loss (16.33, 17.04 and 25.27% respectively). On the other hand, using maltodextrin improved the shrinkage, diameter reduction and cooking loss of low fat beef burgers in compare with those of high beef burger control. Similarly (Desmond *et al.,* 1998) found that less shrinkage in low fat patties containing oat flour compared to no binder.

According to data tabulated in Table (6), it could be mentioned that cooking yield of beef burgers had a high significant increase when compared with control sample. Overall, 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).

Table (6): Changes in shrinkage, diameter reduction, cooking loss and cooking yield of burgers formulas

Treatments	% Shrinkage M±SD	% Diameter reduction M±SD	% Cooking loss M±SD	% Cooking yield M±SD
HFC	16.33^{a} ±0.58	17.04^{a} ±0.64	25.27^{a} ±0.23	74.73^{d} ±0.23
LFC	12.67^{b} ±2.89	12.96^{b} ±3.21	18.84^{c} ±0.28	81.16^{b} ±0.28
LFBB1	12.67^{b} ±1.53	12.96^{b} ±1.70	15.98^{d} ±0.93	84.02^{a} ±0.93
LFBB2	11.67^{b} ±1.15	11.85^{b} ±1.28	18.81^{c} ±0.51	81.19^{b} ±0.51
LFBB3	11.67^{b} ±1.15	11.85^{b} ±1.28	20.70^{b} ±1.05	79.30^{c} ±1.05
Sign	*	*	**	**

HFC= High fat control (20% fat); LFC= Low fat control (10% fat); LFBB1= Low fat beef burger (10% fat + 2.5% maltodextrin); LFBB2= Low fat beef burger (7.5% fat + 5% maltodextrin); LFBB3= Low fat beef burger (5% fat + 7.5% maltodextrin); *= Significant; **= high Significant; NS= No Significant; M= Means of 3 replicates; SD= Standard Deviation; Means with the same letter in each column are not significantly different (p≤0.05).

Organoleptic evaluation of cooked beef burgers.

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 parameters of organoleptic evaluation had no significant differences at P>0.05 except color had a significant differences (p≤0.05) between high fat beef burger control and other treatments. Furthermore, the lowest value of color was observed with high fat beef burger control (20% fat), while low fat beef burger containing 7.5% maltodextrin recorded the lowest flavor, juiciness, texture and overall acceptability. Whereas, the lowest appearance was obtained from low fat beef burger which formulated with 5% maltodextrin.

Table (7): Organoleptic evaluation of cooked beef burgers.

Treatments	Color M±SD	Flavor M±SD	App M±SD	Ju M±SD	Tex M±SD	OA M±SD	Total M±SD
HFC	6.15^{b} ±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^{a} ±0.97	41.75^{a} ±5.14
LFBB1	7.60^{a} ±0.70	6.60^{ab} ±1.17	7.25^{a} ±1.14	6.80^{a} ±1.32	7.15^{a} ±1.20	7.15^{a} ±1.63	42.55^{a} ±5.35
LFBB2	7.10^{a} ±0.99	6.20^{ab} ±0.92	6.60^{a} ±1.35	6.95^{a} ±1.17	6.30^{a} ±1.70	6.40^{a} ±1.84	39.55^{a} ±5.73
LFBB3	7.50^{a} ±1.08	6.00^{b} ±1.63	6.90^{a} ±1.45	5.90^{a} ±1.37	6.30^{a} ±1.49	6.25^{a} ±2.18	38.85^{a} ±7.14
Sign	*	NS	NS	NS	NS	NS	NS

HFC= High fat control (20% fat); LFC= Low fat control (10% fat); LFBB1= Low fat beef burger (10% fat + 2.5% maltodextrin); LFBB2= Low fat beef burger (7.5% fat + 5% maltodextrin); LFBB3= Low fat beef burger (5% fat + 7.5% maltodextrin); App= Appearance; OA= Overall Acceptability; *= Significant; **= high Significant; NS= No Significant; M= Means of 3 replicates; Ju= Juiciness; Tex= Texture; SD= Standard Deviation; Means with the same letter in each column are not significantly different (p≤0.05).

Biology Evaluation

Glucose and lipid profile of rat blood serum fed with different diets of beef burger

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

In addition, the lowest value of blood glucose was obtained from rats group fed on low fat beef burgers with 7.5% maltodextrin.

Group 2 (positive control) which fed on high fat diet rats showed high significant (P<0.01) increase in total cholesterol when compared with all groups included basal diet (negative control) group. The lowest cholesterol value being 60.40 mg/dl was observed in group 4 which fed on diet

formulated with 2.5% maltodextrin. On contrast, the highest value of total cholesterol was 98.37 mg/dl for group 2 followed by rats in group 3 which fed on low fat beef burgers prepared with 10% fat without fat replacer.

Also, triglycerides were increased in positive control group and low fat control group ranged from 224.50 and 214.03 mg/dl in compare with 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 maltodextrin as fat replacer.

Table (8): Glucose and lipid profile of rat blood serum fed on different diets of beef burger formulas

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^{b} ±3.37	72.97^{c} ±3.70	110.77^{b} ±4.92	33.00^{b} ±1.67	17.81^{c} ±3.83	22.15^{b} ±0.98
2	106.53^{a} ±4.70	98.37^{a} ±6.36	224.50^{a} ±9.17	17.80^{c} ±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^{c} ±0.70	27.09^{b} ±4.38	42.81^{a} ±5.28
4	78.97^{b} ±2.35	60.40^{d} ±3.21	110.20^{b} ±18.07	41.10^{a} ±2.60	-2.74^{e} ±2.66	22.04^{b} ±3.62
5	72.87^{bc} ±2.70	71.97^{c} ±3.23	108.50^{b} ±14.23	39.97^{a} ±1.54	10.30^{d} ±0.86	21.70^{b} ±2.85
6	68.87^{c} ±7.03	66.20^{dc} ±3.69	91.37^{b} ±16.24	41.57^{a} ±3.07	6.36^{d} ±3.33	18.27^{b} ±3.25
Sign	**	**	**	**	**	**

LDL-C= Low Density Lipoprotein Cholesterol; VLDL-C= Very Low Density Lipoprotein Cholesterol; HDL-C= High Density Lipoprotein Cholesterol; TC= Total Cholesterol; TG= Triglycerides *= 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 (p≤0.05).

Results of serum lipid profile were summarized in Table (8). All rats groups had a highly significant (P<0.01) difference in HDL-cholesterol value ranging from 17.80 to 41.57mg/dl.

High Density Lipoprotein (HDL) values could be arranged descendingly as follows: Group 6 > Group 4 > Group 5 > Group 1 > Group 3 > Group 2 being 41.57, 41.10, 39.97, 33.00, 19.37 and 17.80 mg/dl. There was highly significant difference (P<0.01) in LDL-cholesterol content between all treatments. The positive control recorded the highest value of LDL-cholesterol in compare with low fat beef burgers which formulated with fat replacers.

Data showed that positive control had the highest VLDL-cholesterol being 44.90mg/dl followed by low fat control group (42.81mg/dl). Furthermore, there was a high significant differences in VLDL-cholesterol contents between all treatments and positive control (18.27 – 44.90 mg/dl)

except for low fat control group which recorded second highest VLDL-cholesterol.

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

Estimation of GPT and GOT is known as liver function tests (LFTs) and is used to monitor damage to the liver parenchymal cells (Choudhury *et al.,* 2011, Hsueh *et al.,* 2011 and Huang *et al.,* 2006). Moreover, the serum level of glutamic pyruvic transaminase (GPT) was evaluated as an indicator of fatty liver (Kawasaki *et al.,* 1997).

From data listed in Table (9) it could be noticed that after 6 weeks feeding, there is a high significant increase (P<0.01) in GPT (ALT) levels between all rats groups and negative control group. On the other hand, no significant difference between group 6 (7.5% maltodextrin + 5% fat) and negative control (basal diet). Furthermore, data presented in Table (9) showed that the lowest GPT obtained from group 1 and group 6, while group 2 (positive control) recorded the highest level of GPT.

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^{c} ±11.40	27.63^{c} ±15.59	0.53^{b} ±0.05	44.07^{b} ±3.76	2.05^{c} ±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^{b} ±3.84	1.04^{a} ±0.08	62.97^{a} ±2.60	3.23^{b} ±0.08
4	53.93^{b} ±5.46	24.90^{c} ±5.99	0.46^{b} ±0.05	42.03^{bc} ±3.62	1.11^{d} ±0.12
5	49.90^{b} ±3.90	20.40^{c} ±4.26	0.40^{b} ±0.03	36.47^{c} ±4.91	0.91^{d} ±0.16
6	26.57^{c} ±4.76	35.03^{c} ±6.30	0.48^{b} ±0.03	45.97^{b} ±3.31	0.93^{d} ±0.10
Sign	**	**	**	**	**

GPT= Glutamic Pyruvic Transaminase; GOT Glutamic Oxaloacetic Transaminase; *= 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 (p≤0.05).

Data presented in Table (9) showed that the effect of beef burgers prepared with different levels of maltodextrin on GOT (AST) of rats after feeding for 6 weeks. There was a high significant increase in GOT between positive control group and 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 and 2.5% maltodextrin respectively followed by basal diet (negative control) group.

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

At the end of experimental period for creatinine, (Table, 9). It could observed that a high significant differences ($P<0.01$) between all rats groups comparing to positive control group. Moreover, the lowest value of creatinine (0.40 mg/dl) obtained from rat group 5 which feeding on diet containing 5% maltodextrin. On contrary, positive control group recorded the highest value of creatinine (1.19 mg/dl).

The level of urea in the 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 ($P<0.01$) in urea levels of positive control when compared with other groups included negative control except low fat control group had no significant.

Table (9) showed that lowest value of urea (36.47 mg/dl) obtained from group 5 which feeding on diet containing 5% maltodextrin + 7.5% beef back fat followed by negative control (44.07 mg/dl). 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).

Finally, the results obtained from Table (9) illustrated that uric acid of positive control group had a high significant ($P<0.01$) increase when compared with other rats groups. Furthermore, the highest value of uric acid (3.64 mg/dl) was obtained from rats group 2 which feeding on diet containing 20% beef back fat. While, rats group 5 had the lowest level (0.91 mg/dl) followed by rats group 6.

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الخواص الطبيعية والكيميائية والحيوية لبرجر اللحم منخفض الدهن باستخدام المالتودكسترين

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استخدم المالتودكسترين كبديل للدهن في إعداد برجر اللحم منخفض الدهن بنسب استبدال ٢.٥، ٥ و ٧.٥%. تم إجراء تقييم للخواص الكيميائية والفيزيائية وخواص الطبخ ومنها قياسات القوام وفقد الطبخ بالإضافة إلى التقييم البيولوجي. أشارت النتائج إلى أن إضافة المالتودكسترين أدت إلى زيادة نسبة الرطوبة، الكربوهيدرات والألياف الغذائية وإنخفاض كمية الدهون بالمقارنة مع عينة برجر اللحم الكنترول. أظهر التحليل الإحصائي للخصائص الفيزيائية أن هناك فروق معنوية في كل من صفتي الانكماش ونقص القطر، في حين لم يلاحظ أي اختلافات في قياسات قوام برجر اللحم المعد باستخدام المالتودكسترين. أظهر البرجر المعد انخفاض في الكوليسترول الكلي (٦٦.٢٠)، والجليسريدات الثلاثية (٩١.٣٧). بينما، وصلت الليبوبروتينات المنخفضة والمرتفعة الكثافة (٣٩.٩٧) و (٦.٣٦) بالمقارنة مع كل عينات البرجر الكنترول ٣٣.٠٠ و ١٧.٨٠، ١٧.٨١ و٣٥.٦٧ على التوالي.

لذلك يقترح هذا البحث أن المالتودكسترين له تأثير في تحسين الخواص الفيزيائية والكيميائية والخواص الوظيفية لبرجر اللحم وكان له تأثير خافض لدهون الدم في فئران التجارب.