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Effect of Replacing Fat with some Plants Powders on Nutritional Quality Criteria of Chicken Burger Patties

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ABSTRACT

The present study was carried out to evaluate the effect of partial replacement of fat with ascending levels (25, 50 and 75%) of globe artichoke (GA) or jerusalem artichoke (JA) powders in chicken burger formula. The effect of GA and JA on the quality characteristics of produced chicken burger were investigated. Also, fatty acids and total calories were evaluated. The results indicated that the incorporation of GA or JA powders into chicken burger formula instead of chicken burger fat decreased their contents of total lipids, total calories and total saturated fatty acids, while increased their contents of protein, ash, crude fiber, carbohydrates, unsaturated fatty acids and the ratio of unsaturated/saturated fatty acids as compared to control chicken burger sample. Also, GA or JA formulations caused an improving of physicochemical quality criteria (pH value, WHC, cooking loss, cooking shrinkage, cooking yield, fat retention, moisture retention, plasticity and tenderness). Chicken burgers containing GA or JA exhibited a good sensory properties and better acceptability, especially those contained 25 and 50% fat replacement levels by GA or JA. This study recommended that it should be incorporated of these promising healthy nutrients for production of low fat chicken burger by replacing of fat with globe artichoke or jerusalem artichoke in chicken burger. These products could be useful for some people who suffer from obesity or cardiovascular diseases.

Key words: Fat substitute, low fat, chicken burger, Globe artichoke, Jerusalem artichoke,

Introduction

Several health problems, such as obesity and cardiovascular diseases, can be associated with excessive consumption of highly saturated animal fats (O'Neil, 1993). Burgers are usually a feature of fast foods, most fast foods contain extremely high levels of trans fatty acids, which can lead to obesity, type 2 diabetes and coronary disease. Studies have shown that the diets which are rich in saturated fats and trans fats (like burger) increase the level of low density lipoprotein (LDL) cholesterol in blood that clogs the arteries. Individuals who eat fast food regularly had a much lower intake of fruits and vegetables (Zoraida *et al.,* 2011). As a result, consumer awareness of the connection between nutrition and health has risen (Jimenez, 2000).The health benefits derived from fat reduction in foods have been recognized in the prevention and treatment of different illnesses (Dentali, 2002).

However, fat is very important in producing desirable sensory characteristics of food products including processed meat items , Fat stabilizes the meat emulsion, reduces cooking loss, improves water holding capacity and provides juiciness and hardness (Yoo *et al.,* 2007). Furthermore, fat plays an important role in affecting sensory characteristics (appearance, flavor and texture) and consumer acceptance (Weiss *et al.,* 2010). In many cases, low fat foods have been largely rejected by the consumers because they were considered less juicy, firmer, more rubbery, darker in color and overall less acceptable than traditional meat products (Keeton, 1994). The reduction of fat in meat emulsions can also provoke changes in emulsion stability parameters, such as fat and water losses during cooking, and thus affecting the final quality (Alvarez *et al.,* 2007).

The addition of dietary fibers can also be considered a viable way to reduce animal fat in meat products, by means of using natural ingredients as fat replacers. Dietary fiber can lead to a compact gel

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formation due to the fiber´s ability to retain fat and water (Fernandez-Gines *et al.,* 2005), which can improve structural integrity, yield and adhesiveness in reduced fat products (Tokusoglu and Kemal, 2003).

Globe artichoke and jerusalem artichoke tubers have a high concentration of inulin (Baldini *et al.,* 2004 and Orlovskaya *et al.,* 2007), thus made it one of the good sources of inulin. Low fat patties could be produced by replacing fat with jerusalem artichoke (boiled or dried) up to 75% fat replacement level (EL-Beltagy *et al.,* 2007). Adding jerusalem artichoke to meat products such as sausages would supply the requisite quantities of inulin and natural antioxidants, may extend the shelf-life of food products (Gedrovica and Karklina, 2013). Incorporation of globe artichoke into beef burger patties, as a good functional and nutritional properties meat replacer, at levels, 10, 20, 30% of meat weight used in burger patties formulation resulted in producing burger patties without detrimental effect on the sensory attributes besides improving physiochemical properties and cooking measurements of the product (Abd-Elhak *et al.,* 2014).

To the best of our knowledge, limited researches has been published on the use of globe artichocke and jerusalem artichoke as fat replacers in chicken burger. Therefore, the current study aimed to evaluate the effect of replacing fat by adding different levels of globe artichoke and jerusalem artichoke in formula of chicken burger patties on the chemical composition, physico-chemical properties, caloric values, fatty acids profile and sensory characteristics of chicken burger.

Materials and Methods

Materials:

Plant materials:

Globe artichoke (*Cynara scolymus* L.) and jerusalem artichoke tuber (*Helianthus tuberosus* L.) were obtained from Agricultural Research Centre, Giza, Egypt. The tubers were harvested in autumn and packed in plastic bags then transported to the laboratory for use.

Chicken burger ingredients:

Chicken meat obtained from the local butcher shop in the day before experiment, Soybean flour was obtained from food Technology Research Institute, Agriculture Research Center, Giza, Egypt. All spices, fresh eggs, Bread crust powder, onion and salt (sodium chloride) were obtained from the local market.

All currently used chemicals were obtained from Sigma chemical Co.

Methods:

Experimental Treatments:

Preparation of globe artichoke (GA) and jerusalem artichoke (JA) powders:

Fresh globe artichoke edible heads (GA) and jerusalem artichoke tubers (JA) were washed with tap water to remove the dust followed by distilled water and cutted into slices 2 mm using Braun slicer machine (Combi Max 700), then soaked in diluted lemon juice (acidic solution) to inhibit the activity of polyphenol oxidase as recommended by Tchone *et al.,* (2005). The obtained acidified slices were transferred directly to an electric oven and dried at 55° C for 12 hr. for GA and at 50ºC ± 2° C for 12 hr. for JA. The dried plant samples were ground into a fine powder in a mill and sieved (20 mesh sieve) to fine particles. The materials that passed through a sieve were retained for use. Finally, the obtained powders of GA and JA were packed in polyethylene bags and stored at room temperature in a dry place to avoid moisture absorption as recommended by Modler *et al.,* (1993).

Preparation of chicken burger patties:

The different formulations of chicken burger patties prepared as shown in table (1). The control chicken burger formula consisted of 50% chicken breast (max. 1.8 % fat) and 20% fat. Spices used were ground black pepper (0.6%), and cumin (0.33%); salt (1.5%), Soybean flour (10%), onion (7%) and Bread crust powder (5%) were also used in the formulation as according to Abd-Elkhalik, (2011). The other chicken burger formulations were prepared by partial replacement of fat with ascending levels of GA or JA powders as shown in table (1).

Table 1: Formulation of high and low fat chicken burger with Globe artichoke (GA) and Jerusalem artichoke (JA) as fat replacers

Ingredients (%)	Control	Globe artichoke			Jerusalem artichoke		
		25%	50%	75%	25%	50%	75%
Chicken breast	50	50	50	50	50	50	50
Fat	20	15	10	5	15	10	5
Globe artichoke	-	5	10	15	-	-	-
Jerusalem artichoke	-	-	-	-	5	10	15
Fresh onion	7	7	7	7	7	7	7
Whole egg	5	5	5	5	5	5	5
Bread crust powder	5	5	5	5	5	5	5
Soybean flour	10	10	10	10	10	10	10
Sodium chloride	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Powder spice mixture	0.913	0.913	0.913	0.913	0.913	0.913	0.913
Water	0.587	0.587	0.587	0.587	0.587	0.587	0.587

Cooking of chicken burger patties:

The chicken burger patties (control and containing different levels of GA or JA powders) were cooked in a preheated electrical grill for a total 5 min. (2.5 min. on each side) at 70º C before being coded and evaluated by sensory evaluation (Gehan Kassem and Emara, 2010).

Analytical methods:

Chemical analysis:

Proximate composition of raw materials and the tested chicken burger patties were determined according to A.O.A.C. (2000) as following: moisture (70ºC overnight), protein (N×6.25), ether extract (petroleum ether 40-60/16h), ash (550ºC overnight), fiber and total carbohydrates by difference.
Total carbohydrates (%) = 100 - (% crude protein + % fat + % ash + % fiber).

Inulin content in dried globe artichoke edible heads (GA) and jerusalem artichoke tubers (JA) were performed by HPLC analysis using the method described by Hao *et al.,* (2010).

The energy values were calculated theoretically according to the method described by Paul and Southgate, (1979) as follows:
Energy value = 4 (g Protein + g carbohydrates) + 9 (g Fat).
Caloric value of Inulin = 1.25 Kcal /g (Mullin *et al.,* 1994).

Physical analyses:

The pH values for chicken burger patties were measured by using calibrated pH meter according to the method described by Fernandez-Lopez *et al.* (2006). Tenderness was measured by using the Warner-Bratzler shear force apparatus as shear force (N/cm^2) according to Herring, (1976). Calculation of cooking loss was determined according to Raharjo *et al.* (1995), while cooking yield was calculated according to Adams, (1994). Water holding capacity (WHC) and plasticity were determined by filter press method of Soloviev, (1966). Also, moisture retention value was determined according to El-Magoli *et al.*(1996). While, fat retention was calculated according to the method described by Murphy *et al.* (1975).

$$\text{Moisture retention (\%)} = \frac{\text{(percent yield} \times \text{\% moisture in cooked patties)}}{100}$$

$$\text{Fat retention (\%)} = \frac{\text{(cooked weight} \times \text{percent fat in cooked meat patties)}}{\text{(raw weight} \times \text{percent fat in raw meat patties)}} \times 100$$

$$\text{Cooking yield} = \frac{\text{cooked weight}}{\text{raw weight}} \times 100$$

Determination of fatty acids composition:

The fatty acid profiles for oil extracted from chicken burger control and tested chicken burger samples were determined as methyl ester by gas liquid chromatography (GLC). Methyl ester was prepared using BF_3 methanol as methylating agent according to the A.O.A.C. (2005) and Patrick *et al*. (2014).

Sensory evaluation:

Sensory evaluation for chicken burger control and tested chicken burger samples were evaluated. Cooked chicken burgers were left to cool at room temperature for 15 minutes before being subjected to organoleptic evaluation as described by Basker, (1988). The cooked chicken burger samples were evaluated by twenty panelists of staff members and graduate students of Food science and Technology Department, Faculty of Agriculture, Cairo Al-Azhar University. Panel members were asked to evaluate different cooked chicken burger samples for color, odor, taste, texture, tenderness, Juiciness and overall acceptability on a 10 point hedonic scale. The hedonic scale was as follows: 1–3 (not acceptable); 4–5 (fairly acceptable); 6-7, (good acceptable); and 8-10, very good (Gok *et al.,* 2008).

Statistical Analysis:

The obtained results were analyzed using analysis of variance (ANOVA) and least significance difference (LSD) at a significance probability 5 % according to Steel and Torrie, (1980).

Results and Discussion

Proximate chemical composition and inulin content of raw materials*:*

The chemical composition of globe artichoke, jerusalem artichoke and chicken meat (on dry weight) are tabulated in table (2). From the same table, it could be observed that there were significant ($P \leq 0.05$) differences among the studied raw materials in their chemical components. Globe artichoke and jerusalem artichoke contained the highest amounts of total carbohydrates (65.61 and 78.42%), inulin of total carbohydrates (45.67 and 78.64%) and crude fiber (10.89 and 6.57%). Also, from the same table noticed that the jerusalem artichoke contained significantly ($P \leq 0.05$) higher level of total carbohydrates and inulin content than globe artichoke. On the other hand crude fiber, carbohydrates and inulin not detected in chicken meat.

Table 2: Chemical analysis (on dry weight) for Globe artichoke flour (GAF), Jerusalem artichoke flour (JAF) and Chicken meat.

Raw Materials	Chemical Composition (%)							
	Moisture	* Crude protein	* Ether extract	*Ash	*Crude Fiber	*Total Carbohydrates	*Inulin (% of total carbohydrates)	Calories (kcal/100g)
GA	83.19^{a}	14.34^{b}	2.38^{b}	6.78^{a}	10.89^{a}	65.61^{b}	45.67^{b}	43.8^{b}
JA	75.81^{b}	7.65^{c}	1.70^{c}	5.66^{b}	6.57^{b}	78.42^{a}	78.64^{a}	45.4^{b}
Chicken meat	74.98^{b}	87.81^{a}	7.24^{a}	4.95^{c}	--	--	--	104.5^{a}

The means within the same column having different superscript are significantly varied ($P \leq 0.05$).
**on dry weight*

From the same table, it could be also observed that globe artichoke and jerusalem artichoke contained an adequate percentage of protein, ether extract and ash which were found to be as 14.34, 2.38 and 6.78% in globe artichoke and 7.65, 1.70 and 5.66% in jerusalem artichoke, respectively. Concerning the caloric values, globe artichoke and jerusalem artichoke contained significantly ($P \leq 0.05$) lower levels (43.8 and 45.4 kcal/100g) respectively, which reflect the important of this plants for low calories sources, than chicken meat (104.5 kcal/100g wet basis). These results are in agreement with the foundations of Zhao-liang *et al.,* (2008); Gaafar *et al.,* (2010); Lutz *et al.,* (2011) and El-Sohaimy, (2014)

Quality criteria of tested chicken burger patties:

A- Gross chemical composition for chicken burgers containing different levels of globe artichoke and jerusalem artichoke as partial fat replacers:

The proximate chemical composition of prepared chicken burger as affected by replacing fat with different levels (25, 50, and 75%) of globe artichoke and jerusalem artichoke flours are presented in Table (3).

Table 3: Chemical composition of chicken burger affected by different levels of Globe artichoke and Jerusalem artichoke as partial fat replacers

Parameter	Control	Globe artichoke			Jerusalem artichoke		
		25%	50%	75%	25%	50%	75%
Moisture	58.44^{b}	58.89^{b}	59.26^{ab}	59.81^{ab}	59.39^{ab}	60.23^{ab}	60.82^{a}
*Crude protein	36.91^{c}	37.62^{bc}	38.34^{ab}	39.06^{a}	37.29^{bc}	37.67^{bc}	38.05^{abc}
*Ether extract	48.36^{a}	36.60^{bc}	24.78^{c}	12.79^{d}	37.01^{bc}	25.31^{c}	13.01^{d}
*Ash	4.84^{c}	5.17^{bc}	5.51^{ab}	5.85^{a}	5.12^{bc}	5.40^{abc}	5.68^{ab}
*Fiber	2.20^{d}	2.74^{bc}	3.28^{b}	3.83^{a}	2.52^{cd}	2.85^{bc}	3.18^{b}
*Carbohydrates	7.69^{e}	17.87^{d}	28.09^{c}	38.47^{b}	18.06^{d}	28.77^{c}	40.08^{a}
Calorie value (kcal/100 g)	254.9^{a}	226.5^{b}	198.4^{c}	170.8^{d}	224.3^{b}	196.2^{c}	168.2^{d}

Means values in the same row showed the same superscript small letter is significantly different (p≤0.05).
**on dry weight*

Results shows that there is no significant differences in moisture content of different low fat chicken burger blended samples and control. On the other hand, the moisture content of chicken burger samples treated by globe artichoke and jerusalem artichoke was increased with increasing the replacement level. Moisture content of chicken burger blends of globe artichoke and jerusalem artichoke was ranged from 58.89 to 59.81% and 59.39 to 60.82 % respectively, while moisture for control sample was recorded 58.44%. The same table showed that protein content in chicken burger containing globe artichoke and jerusalem artichoke was significantly ($P \leq 0.05$) higher than control. A remarkable increase was noticed at the level of globe artichoke and jerusalem artichoke (75%) which recorded 39.06 and 38.05 %, respectively.

From the same table, illustrated that the control sample had the highest ether extract content (48.36%), while chicken burgers having different levels of globe artichoke or jerusalem artichoke had the lower ether extract contents. On the contrary, the fiber content in control sample was the lowest value of other chicken burger samples. Incorporation of globe artichoke or jerusalem artichoke flours into chicken burger formula with the reduction of the added fat significantly increased the contents of total fibers and reduced the contents of total lipids for the resultant chicken burger formulations, proportionally to the added globe artichoke or jerusalem artichoke fibers. Fiber content of all samples which contained GA or JA was higher than control sample. These results are in quite comparable to those obtained by Crehan *et al.,* (2000); El-Beltagy *et al.,* (2007) and Abd-Elhak *et al.,* (2014). Regarding the ash and carbohydrate contents, replacement of fat content with adding different levels globe artichoke or jerusalem artichoke showed significantly ($P \leq 0.05$) higher ash and carbohydrate contents. Similar results were obtained by Sadettin *et al.,* (2005) and El-Beltagy *et al.,* (2007).

The same table illustrated that the fat content decreased or level of globe artichoke and jerusalem artichoke replacement increased, in chicken burger formulas, total calories declined. Reduction rates in calories content of patties ranged from 12% (at 25% replacement level) to 34% (at 75% replacement level). These results indicated that formulation patties with globe artichoke or jerusalem artichoke considered a good method for caloric reduction which is very important for consumers restricted for their fat intake. These results were in accordance with those noticed by Sadettin *et al.,* (2005); El-Beltagy *et al.,* (2007); Abd-Elhak *et al.,* (2014) and Newlove *et al.,* (2015).

B- Physico-chemical Quality Criteria for chicken burger containing different levels of globe artichoke and jerusalem artichoke as fat replacers:

Physico-chemical quality criteria of chicken burger samples such as pH value, WHC, plasticity $cm^2/0.3gm$ and tenderness (shear force value N/cm^2) were significantly ($P \leq 0.05$) affected by addition of globe artichoke or jerusalem artichoke flours as partial fat replacers into the chicken burger formula as shown in Table (4).

From these results it could be noticed that the pH values of different chicken burger samples ranged from 5.40 to 5.79 with non-significant differences between the control sample and samples contained fat replacement level (25 % by globe artichoke or jerusalem artichoke). While, significant differences ($P \leq 0.05$) in pH values were recorded among the other treatments. The pH value was decreased by increasing the levels of globe artichoke or jerusalem artichoke. This decrease might be due to the low pH value of globe artichoke and jerusalem artichoke (Vincenzo *et al*., 2009 and Abd-Elhak *et al*., 2014). These results are similar to those reported by Khalil, (2000).

Table 4: Physico-chemical properties of chicken burgers affected by different levels of Globe artichoke and Jerusalem artichoke as partial fat replacers

Parameters	Control	Globe Artichoke			Jerusalem Artichoke		
		25%	50%	75%	25%	50%	75%
PH	5.79^{a}	5.62^{ab}	5.47^{b}	5.40^{b}	5.67^{ab}	5.52^{b}	5.44^{b}
WHC	55.75^{e}	59.00^{d}	61.75^{c}	63.80^{b}	61.15^{c}	63.77^{b}	67.11^{a}
Plasticity(cm^2/0.3g)	3.17^{b}	3.30^{ab}	3.34^{a}	3.39^{a}	3.32^{ab}	3.38^{a}	3.43^{a}
Tenderness	1.04^{b}	1.10^{ab}	1.16^{ab}	1.23^{ab}	1.12^{ab}	1.20^{ab}	1.27^{a}

Means values in the same row showed the same superscript small letter is significantly different ($p \leq 0.05$).

The same table, illustrated that water holding capacity (WHC) was significantly ($P \leq 0.05$) increased with increasing the replacement level. The highest WHC was observed in 75% replacement level in jerusalem artichoke (67.11%) followed by 75% in globe artichoke (63.80%), whilst the lowest WHC was observed in control sample (55.75%). Also, no significant differences were noticed between the two replacers types while, both of them were higher than control. This increase in water holding capacity values might be attributed to the ability of inulin in globe artichoke and jerusalem artichoke flack to absorb and keep or binding more of water (Rehab *et al*., 2011). These results are in close approximately agreement with those reported by El-Beltagy *et al.,* (2007).

Plasticity values took the same trend of WHC values. Plasticity values increased by increasing fat replacers percentages (globe artichoke and jerusalem artichoke). The highest value (3.43 cm^2/0.3g) was recorded for chicken burger sample prepared by substitution fat with jerusalem artichoke at 75%. On the other hand, the lowest value (3.17 cm^2/0.3g) recorded for high fat chicken burger treatment control. Generally, globe artichoke or jerusalem artichoke improved the plasticity of low-fat chicken burger. These results are in line with the findings of Sanaa, (2015), who found that wheat bran and barley improved the plasticity of low fat beef sausage.

Table (4), also illustrated that the tenderness value as shear force value (N/cm^2). From these results it could be noticed that significant differences ($P \leq 0.05$) were found among the control sample and other samples treated by globe artichoke or jerusalem artichoke. Shear force values were decreased as reason of increasing addition levels of globe artichoke or jerusalem artichoke to the formulation of chicken burger and the decrease in shear force value means high tenderness of samples. The decreasing in tenderness on control sample may be due to juice loss and reduction in moisture content of chicken burger. These results are in contrast with those obtained by Soher *et al.,* (2013).

C- Cooking measurements for chicken burger containing different levels of globe artichoke and jerusalem artichoke as fat replacers:

Cooking loss, shrinkage, cooking yield, moisture and fat retention of chicken burger are presented in Table (5).

As shown in Table (5), cooking loss and shrinkage percentages of chicken burger samples containing globe artichoke or jerusalem artichoke at different levels were lower ($P \leq 0.05$) than the control. Cooking loss percentage of produced high-fat chicken burger trials decreased with increasing the incorporation level of globe artichoke or jerusalem artichoke as partial fat replacers into the chicken burger formula, this is could be attributed mainly to increase the water holding capacity of chicken burgers as the result of increasing crude fibers and carbohydrates content (Rocha-Garza and zayas,1996). While, the highest cooking loss was from the control chicken burger sample, due to the high loss of fat and moisture during cooking. The cooking losses of the samples decreased with more globe artichoke or jerusalem artichoke addition. The percentage of diameter shrinkage are on the line with cooking loss, the smallest reduction in patty diameter (7.7%) was found in samples formulated with 25% fat and 75% jerusalem artichoke, the greatest change in diameter (19.4%) was recorded for control samples (100% fat level). The present results are in conformity with those reported by Tekin *et al.,* (2010); Soher *et al.,* (2013) and Abd-Elhak *et al.,* (2014).

Table 5: Cooking measurements of chicken burger affected by different levels of Globe artichoke and Jerusalem artichoke as partial fat replacers

Parameter	Control	Globe Artichoke			Jerusalem Artichoke		
		25%	50%	75%	25%	50%	75%
Cooking Loss (%)	19.74^{a}	16.10^{b}	14.38^{c}	12.11^{d}	14.60^{c}	12.18^{d}	10.04^{e}
Shrinkage (%)	19.4^{a}	13.1^{b}	11.0^{c}	9.0^{d}	12.0^{bc}	9.6^{d}	7.7^{e}
Cooking Yield (%)	80.26^{d}	83.90^{c}	85.62^{c}	87.89^{b}	85.40^{c}	87.82^{b}	89.96^{a}
Moisture Retention (%)	65.72^{g}	69.96^{f}	73.85^{d}	77.98^{b}	71.87^{e}	75.82^{c}	79.87^{a}
Fat Retention (%)	76.19^{e}	79.86^{d}	82.27^{c}	84.98^{ab}	81.52^{cd}	83.69^{bc}	86.12^{a}

Means values in the same row showed the same superscript small letter is significantly different ($p \leq 0.05$).

Significant ($P \leq 0.05$) increases in moisture retention were noticed in chicken burger formulated with different levels of globe artichoke or jerusalem artichoke compared with control. The highest increase in moisture retention was noticed for 75% replacement level (79.87%) by jerusalem artichoke. The observed increase in moisture retention may be due to the ability of inulin to absorb and keep more water and the decrease in fat content which decrease the hydrophopicity of the formulas (El-Beltagy *et al.,* 2007). These results clearly showed that the addition of globe artichoke or jerusalem artichoke flours increased the moisture retention of cooked chicken patties. Similar results are noticed with Meltem, (2006) and El-Beltagy *et al.,* (2007).

The same trend were observed with cooking yield which significantly ($P \leq 0.05$) improved by replacing fat with both artichoke types. The highest cooking yield (89.96%) was observed in chicken burger formulated with 75% fat replacement level by jerusalem artichoke followed by that of 75% by globe artichoke (87.89%) to the ability of inulin to absorb and keep more water and/ or the decrease in fat content which decrease the hydrophopicity of the formulas. Similar improvements in cooking yield have been reported by Khalil, (2000); Meltem, (2006) and El-Beltagy *et al.,* (2007).

D- Fatty acid profiles for chicken burgers containing different levels of globe artichoke and jerusalem artichoke as partial fat replacers:

The purpose of the fatty acid composition analysis was to obtain the preliminary results for further research into improvement of the nutritional value of this chicken burgers. One of the objectives of the research project is to modify the fatty acid composition of burgers according to the recommendations of dietary guidelines.
The present data in Table (6), indicated that the fatty acid profiles of lipid separated from chicken burger under investigation.

Table 6: Fatty acids profiles of chicken burger affected by different levels of Globe artichoke and Jerusalem artichoke as partial fat replacers.

Fatty acids	Control	Globe Artichoke			Jerusalem Artichoke		
		25%	50%	75%	25%	50%	75%
$C_{14:0}$	1.06	1.03	0.99	0.96	1.04	0.99	0.97
$C_{16:0}$	28.74	28.68	28.57	28.45	28.71	28.63	28.41
$C_{17:0}$	0.93	0.92	0.90	0.87	0.91	0.89	0.86
$C_{18:0}$	12.95	12.69	12.41	12.12	12.67	12.36	12.08
$C_{18:1}$	41.81	42.07	42.45	42.76	42.04	42.42	42.82
$C_{18:2}$	13.37	13.42	13.47	13.58	13.47	13.52	13.63
$C_{18:3}$	1.14	1.19	1.21	1.26	1.16	1.19	1.23
SFA	43.68	43.32	42.87	42.40	43.33	42.87	42.32
USFA	56.32	56.68	57.13	57.60	56.67	57.13	57.68
U/S ratio	1.28	1.30	1.33	1.35	1.30	1.33	1.36

Lipids of all chicken burger formulations contained the same fatty acids. However, lipids of the control chicken burger formula had the highest content of saturated fatty acids (SFA) reaching 43.68 % of the total fatty acids and the predominant SFA were palmitic $C_{16:0}$, stearic $C_{18:0}$, and myristic $C_{14:0}$, respectively. Meanwhile, the total unsaturated fatty acids (UFA) reached 56.32 % and oleic $C_{18:1}$ was the most abundant monounsaturated fatty acid, while linoleic $C_{18:2}$ and linolenic $C_{18:3}$ were the predominant polyunsaturated fatty acids. Similar results were reported for lipids of beef patties by Bilek and Turhan, (2009). Incorporation of globe artichoke or jerusalem artichoke flours into the chicken burger formula with decreasing of the added chicken fat decreased the contents of SFA in lipids of the different formulated chicken burger samples accompanied with increase of their USFA content, proportionally to the reduction of the added chicken fat. Accordingly, increases in the ratios of unsaturated/saturated fatty acids were observed, indicating an improvement of the chicken burger nutritional content (Table 6). Similar observations were reported for the replacement of the animal fat with vegetable oils in different meat products (Choi *et al*., 2010). It was shown that low-fat, monounsaturated-rich diet reduced the susceptibility of low density lipoprotein peroxidation and may be of therapeutic value in the treatment of hypercholesterolemia (Byrne *et al*., 1998).

Among these fatty acids, the fatty acid $C_{18:1}$ represented the highest relative percentage of all identified fatty acids. Sample containing 25% fat with 75% jerusalem artichoke had higher content of unsaturated fatty acids than other samples. This observation might be due to that this sample containing jerusaelm artichoke had a higher percentage of unsaturated fatty acids (about 57.68%). These results are in close approximately agreement with those reported by Aneta, (2012) who found that all of control and chicken burger samples fortified with 1, 2 or 3 % of inulin were quite rich in unsaturated fatty acids (UFAs) and adding inulin improved the nutritional value of burgers the modification of fatty acid profile is also recommended.

E- Sensory quality criteria for chicken burgers containing different levels of globe artichoke and jerusalem artichoke as partial fat replacers:

Sensory evaluation was carried out in order to evaluate the color, taste, odor, tenderness, juiciness, appearance and overall acceptability of chicken burger treatments as affected by addition of (globe artichoke or jerusalem artichoke) compared with the control sample as shown in Table (7). No significant effect was observed in color, taste and appearance by increasing the fat replacement level up to 75%, except the sample was affected by 50% and 75% jerusalem artichoke its color and taste, adding to appearance of chicken burger sample formulated by 25% fat with 75 % jerusalem artichoke. The same table shows that there were no significant differences among control and samples containing both globe artichoke and jerusalem artichoke at levels 25 and 50 % in both odor, juiciness ,texture and overall acceptability. With regard to the overall acceptability, the chicken burger formulated 25% fat with both globe artichoke or jerusalem artichoke (75%) was the lowest acceptable sample, while the other samples were not significantly different as compared with control.

Table 7: Sensory properties of chicken burgers affected by different levels of Globe artichoke and Jerusalem artichoke as partial fat replacers:

Treatments		Color	Taste	Odor	Juiciness	Texture	Appearance	Overall acceptability
Control (20% fat)		9.1^{a}	9.1^{a}	9.3^{a}	9.0^{a}	8.9^{a}	9.3^{a}	8.9^{a}
Globe Artichoke	25%	9.0^{ab}	9.1^{a}	9.1^{ab}	8.7^{a}	8.5^{ab}	9.2^{ab}	8.9^{a}
	50%	9.0^{ab}	8.9^{a}	9.0^{ab}	8.4^{ab}	8.3^{ab}	9.0^{ab}	8.8^{a}
	75%	8.8^{ab}	8.2^{b}	8.8^{ab}	7.8^{b}	7.7^{c}	8.9^{ab}	7.9^{b}
Jerusalem Artichoke	25%	8.8^{ab}	8.8^{a}	8.8^{ab}	8.9^{a}	8.7^{a}	8.9^{ab}	8.8^{a}
	50%	8.3^{b}	7.5^{c}	8.5^{b}	8.8^{a}	8.5^{ab}	8.7^{b}	8.5^{a}
	75%	7.7^{d}	5.7^{d}	7.1^{c}	8.4^{ab}	8.0^{bc}	8.0^{c}	6.5^{c}

Means values in the same column showed the same superscript small letter is not significantly different.

Finally, no significant effect was observed in sensory characteristics by increasing the fat replacement level up to 50%, specially with globe artichoke while, significant difference ($P \leq 0.05$) was observed in sensory characteristics among chicken burger formulated by 25% fat level with both globe artichoke or jerusalem artichoke (75%) compared with control.

Conclusion

It could be concluded that replacement fat content in regular chicken burger with globe artichoke and jerusalem artichoke resulted in improving physiochemical properties, cooking measurements, fatty acid pattern and sensory quality criteria with lowering the product cost. Moreover, globe artichoke or jerusalem artichoke flours addition decreased saturated fatty acids and cholesterol and increased polyunsaturated fatty acids chicken burgers, which is very significant as far as the health of people is concerned. According to these results, the low fat chicken patties could be produced acceptable by replacing fat with globe artichoke or jerusalem artichoke flours up to 50% fat replacement level.

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