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Peroxide Value (PV) and Fatty Acids of Beef Burger Enriched with Olive oil

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Abstract

This study was conducted to evaluate the Peroxide Value (PV) and Fatty Acids of beef burger enriched with Olive oil. Beef burger were formulated with 0%, 1.0%, 1.5% and 2% olive oil, mixed well with other ingredients, stuffed in cellulose casings, packed in polyethylene bags and stored frozen at -18±2°C for 6 months. Peroxide Value (PV) was determined immediately after processing and at intervals of 3 months post processing, while, fatty Acids was determined at initial time using standard analytical procedures. The data collected from the different treatments were subjected to statistical analysis (Duncan). Within each treatment added olive oil increase, peroxide value (PV) increases ($P<0.05$). The highest peroxide value (PV) was reported at 2.0% olive oil followed by 1.5% then 1.0% (from 4.99 mEq/g to 3.37 mEq/g). There were noticeable increases in peroxide value (PV) by storage period. PV values of these samples were increased from 3.31mEq/g at initial time to 6.03mEq/g at sixth month of storage period. Addition of olive oil to beef burger caused no changes in myristic, palmitic, margaric and stearic acids (saturated fatty acids) and palmitoleic, margaricoleic, oleic and eicosenoic (monounsaturated fatty acids). However, linoleic and linolenic recorded a numerical increase with the increase of olive oil, their values ranged between 6.23-8.83 and 3.62-5.23 mg/100g respectively. The developed product showed lower eicosadienoic (poly-USFA) value than the control sample. The ratio of polyunsaturated to saturated fatty acids in beef burger was found to be 0.20:0.23.

Key words

Beef Burger, PV, Olive oil, Unsaturated Fatty Acids, SFA, PUFA and MUFA

1. Introduction

Sudan has a huge animal resource, estimated to be more than 106 million head 30.37 million cattle, 4.80 million camel, 40.21 million sheep and 31.32 million goats (MLFR, 2015). Meat and meat products are excellent sources of fat, protein, essential amino acids, minerals and vitamins which are important components of the diet of individuals living in the developed

countries (Weiss *et al.*, 2010). Different health organization around the world indicated that mortality rate due to cardiovascular disease (CVD) is at a continuous increase death each year, this account for about one-third of all death globally (DH, 2010). Heart disease is an important cause of mortality in Sudan (Mohammed, 2012). Barton (2010) concluded that the unsaturated fatty acids cause reduction of the coronary heart diseases as a result in eating food rich in it, especially plant oil. Beef burger is very popular with high consumption in many countries (Jimenez-Colmenero, 2007). In beef burger 20-25% of the overall composition is derived from animal fat (Srinivassane, 2011). The intake of saturated fatty acids was found to increase low density lipoprotein (LDL) and cholesterol which are associated with diet-related diseases like cardiovascular disease (CVD) (Mohammed, 2012). One approach to develop healthier fabricated meat products is through reformulation of meat products during processing (Jimenez-Colemenero, 2007). Fat replacements or substitutes are ingredients that contribute a minimum of calories to formulated meats and dramatically alter flavour, juiciness, mouth-feel, viscosity or other sensory and processing properties. Modification of the fatty acid composition is mainly based on the replacement of animal fat with oils that meet dietary recommendations (Fernandez-Gines *et al.*, 2005). The olive tree (*Olea europea* L.) grows in a subtropical climate as a traditional main crop in Mediterranean countries. It probably originates from Mesopotamia and has been cultivated from many centuries in southern European countries bordering the Mediterranean and in North Africa (Murkovic *et al.*, 2004). Olive oil is one of the oldest known vegetable oils mainly produced in the countries surrounding the Mediterranean Sea. Olive oil chemical composition can be classified into two groups as major and minor compounds. Nearly 98% fraction of the olive oil structure includes triacylglycerols (TAG) and the group of glyceridic compounds made up of free fatty acids (FFA) and mono-(MAG) and diacylglycerols (DAG) (Mohammed, 2019). Many studies carried out in the past to develop oils enriched meat products included fermented sausages, bologna sausages of pork and chicken origin. However, there is Meagan information on the enrichment of olive oil in beef products

Objectives:

1- To evaluate the Peroxide Value (PV) and storage period of beef burger enriched with Olive oil

2- To evaluate the fatty acids of beef burger enriched with olive oil.

2. MATERIALS AND METHODS

2.1 Food materials

Fresh beef meat samples were obtained from Animal Production Research Center at *Hilat KuKu* and transferred immediately to the National Food Research Center (NFRC), Department of Animal Products, Khartoum, Sudan, where it was kept frozen at -18±2˚C. Olive oil was purchased from a local pharmacy and stored at room temperature around (25˚C). Animal fat, burgl, skim milk powder, onion, corn flour spices, garlic and sugar were obtained from the local market at Omdurman city. Chemicals and reagents used were obtained from the lab line company-Khartoum. All the chemical and reagents were of analytical grades.

2.2 Methods

2.2.1 Raw material preparation

Frozen beef meat samples were thawn at -3˚C over night, sliced and ground using a meat grinder (Model MG 22I, Indian). Black pepper, coriander and spices were cleaned and ground. Half Kg of soybean flakes was soaked for about two hours in about 1.5 L of cold distilled water until completely hydrated, then excess distilled water was discarded.

2.2.2 Beef burger preparation

Frozen beef meat (700g) was allowed to thaw at room temperature, cut into small pieces and ground with 75g fat, 20g burgl, 5g onion and 2g garlic using a meat grinder (Model MG, 221, Indian). The ground meat was mixed manually with 13g salt, 20g sugar and half of the quantity (50ml) iced water. 25g of skim milk powder, 5g spices, 5g corn flour and 30g bread crumbs. The other half of the iced water and the mixture was mixed manually. The meat mixture was treated separately with 1.0%, 1.5% and 2.0% of Olive oil, having one group as a control and mixed well manually. The homogenous mixture was transferred to manual burger machine and pressed as burger. The product was packed in polyethylene bags and stored at frozen up to six month.

2.2.3 Analytical methods

2.2.3.1 Peroxide Value (PV)

The Peroxide Value was determined according to the standard method of the Association of Official Analytical Chemists (AOAC, 2005).

2.2.3.2 Fatty acids profile

Oil Extraction and Saponification of the lipids was done according to the method of Bligh and Dyer with some modification by Kinsella (1987). Preparation of fatty acid methyl esters (FAME) was done according to the method of Hammond (1986). Gas - liquid chromatography was used to determine the fatty acids.

2.2.3.3 Statistical analysis

The data collected from the different treatments were subjected to analysis of variance and whenever appropriate the mean separation procedure of Duncan was employed (Steel and Torrie, 1980). The SAS program (SAS, 2002), was used to perform the general of liner model (GLM**)** analysis.

3. RESULTS AND DISCUSSION

3.1 Effect of Olive oil enriched and storage period on the Peroxide Value (PV) of beef burger

The effect of olive oil enrichment and storage period on the peroxide value of beef burger is illustrated in Table 1. Within each treatment added olive oil increase, peroxide value (PV) increases ($P<0.05$). The highest peroxide value (PV) was reported at 2.0% olive oil followed by 1.5% then 1.0% (from 4.99 mEq/g to 3.37 mEq/g). Generally, the peroxide values within the permitted level (>10 mEq/g). The current results were in agreement with the results of Caceres *et al.,* (2008). Similar result was found by Muguerza *et al.,* (2002). On line, Mohammed (2019) found that, PV of camel's sausage increased as olive oil increase. Wood *et al.,* (2004) showed that an adverse effects on meat quality defined in terms of shelf life (lipid and myoglobin oxidation) and flavor only occur when the concentrations of α-linolenic acid approach 3% of neutral lipids or phospholipids Olsen *et al*., (2005), concluded that oils enriched meat products are highly susceptible to lipid oxidation because of the presence of a high number of unsaturated fatty acids, and this can lead to product deterioration and development of rancid flavors which result in consumer rejection. There were noticeable increases in peroxide value (PV) by storage period. PV values of these samples were increased by storage period from 3.31mEq/g at initial time to 6.03mEq/g at sixth month of storage. Similar increment was obtained by Basheer (2017), Anwar *et al.,* (2010) and Mohammed (2019). This could be due to the combined effect of the antioxidants (spices, nitrites) added to the beef burger during processing, vacuum packaging and low storage temperature as mentioned by Anwar *et al* ., (2010).

Table 1: Effect of Olive oil enriched on the Peroxide Value (P.V) of beef burger.

Treatments Olive oil level	**P.V (mEq/kg)**			
	Storage period (Months)			
	0	3	**6**	**Treatment mean****
0.0 %	2.49^{g} (±0.25**)**	3.26^{f} (±0.21**)**	4.36^{a} (±0.46**)**	3.37^{D}

1.0%	3.20^{f} (±0.26**)**	4.45^{cd} (±6.85**)**	6.00^{d} (±0.26**)**	4.55^{C}
1.5 %	3.52^{ef} (±0.44**)**	5.02^{c} (±0.46**)**	6.43^{b} (±0.36**)**	4.99^{B}
2.0 %	4.05^{dc} (±0.32**)**	5.99^{b} (±0.31**)**	7.36^{a} (±0.35**)**	5.80^{A}
Storage period mean**	3.31^{C}	4.68^{B}	6.03^{A}	

Values are means ± SD.

Means in the same column bearing same superscript (small letters) are not significantly different (P≥0.05).

3.2 Effect of Olive oil enriched on the fatty acids of beef burger

Saturated fatty acids (SFA) in beef burger showed a liner relationship due to addition of different concentration of olive oil. As olive oil levels increased, the saturated fatty acids (SFA) increased. Table 2. The myristic acid values of beef burger treated with different levels of olive oil (0%, 1.0%, 1.5% and 2.0%) showed the following results (1.20mg/100g, 1.24mg/100g, 1.42mg/100g and 1.47mg/100g respectively. Muguerza *et al* .,(2002) reported that, the pork meat treated with different levels of plant oil (0%, 0.5% and 1.5%) showed Myrestic acid value of 1.34mg/100g, 1.36mg/100g and 1.38mg/100g respectively. In contrast, Jimenez - Colmenero (2007) stated that, the addition of carefully selected oils can reduce the saturated fatty acids contents. As for Palmitic acid values, it was noticed that, the maximum palmatic acid value (30.86 mg/100g) was obtained when 2.0% olive oil was added, where the lowest value (26.56 mg/100g) was obtained when the olive oil concentration was zero. Srinivassane (2011) stated that, the addition of omega-3 from 1.2% to 2.4% to chicken frankfurter had increased the palmitic acid from 17.74mg/100g to 21.11mg/100g. Beef burger treated with different concentrations of olive oil (0%, 1.0%, 1.5% and 2.0%) showed different values of margeric acid (C17:0) (1.51mg/100g, 1.86mg/100g, 2.16mg/100g and 2.37mg/100g) respectively. Fajer *et al*., (2013) reported that, the margaric acid value of breast meat was1.50 mg/100). It was noticed that, as oil levels increased, stearic acid (C18:0) values increased. Beef burger treated with different concentrations of olive oil (0%, 0.5%, 1% and 1.5%) had stearic values of (28.96 mg/100g, 30.56mg/100g, 32.42mg/100g and 33.19mg100g) respectively.

Table 1: Effect of Olive oil enriched on the Saturated Fatty Acids (SFA) of beef burger.

Treatments	Saturated Fatty Acids (SFA)			
	Myristic C14:0	**Palmitic C16:0**	**Margeric C17:0**	**Stearic C18:0**
0.0 %	1.20[a] (±0.42)	26.56[a] (±4.53)	1.57[a] (±0.75)	28.96[a] (±3.67)
1.0%	1.24[a] (±0.38)	28.16[a] (±6.85)	1.86[a] (±1.24)	30.56[a] (±6.97)
1.5 %	1.42[a] (±0.44)	29.97[a] (±6.57)	2.16[a] (±1.25)	32.42[a] (±6.46)
2.0%	1.47[a] (±0.30)	30.86[a] (±4.70)	2.37[a] (±1.00)	33.19[a] (±5.35)

Values are means ± SD.

Means in the same column bearing same superscript (small letters) are not significantly different (P≥0.05).

The enriched beef burger with different concentrations of olive oil showed a linear relationship of mono unsaturated fatty acid (PUFA) Table 3. (As olive oil levels increased, the polyunsaturated fatty acid increased). Beef burger treated with different levels of olive oil (0%, 1.0%, 1.5% and 2.0%) were resulted in plamitoleic acid of (3.56mg/100g, 3.61mg/100g, 3.76mg/100g and 3.86mg/100g) respectively as shown in Table 3. These results were in consistent with that reported by Srinivassane (2011) who stated that, the chicken frankfurter treated with different levels of flax oil (0%, 1.2% and 2.4%) had palmitoleic acid of (4.71mg/100g, 5.25mg/100g and 6.13 mg/100g respectively), as oil level increased, the palmitoleic acid increased. The treated beef burger with 2.0% level of olive oil showed the highest acid content of margeicolic 1.88mg/100g, where the lowest value was1.48mg/100g reported at untreated sample. Hoz *et al.*, (2003) and Huang *et al.*, (2008) who, stated that the main effect of linseed addition was reflected in the fatty acids profile in the muscle of pigs. The highest value of oleic acid reported for beef burger was 39.89 mg/100g at 2.0% level of added olive oil, where the lowest one was 34.86 mg/100g for control sample. Addition of olive oil increased the Eicosadionic acid from 1.25mg/100g at untreated sample to1.84mg/100g at 2.0% of olive oil. Fajer *et al.*, (2013) who, stated that the breast chicken treated with different levels of extruded flaxseed (0%, 5% 10% and 15%) had oleic acid of (33.29mg/100g, 35.29 mg/100g, 33.05mg/100g and 32.17 mg/100g) respectively. Srinivassane (2011) used omega-3 at 1.2% and 2.4% level in chicken frankfurter which had

increased the Eicosadionic acid from 0.36mg/100g to 0.88mg/100g compared to untreated sample which reported 0.34mg/100g. This variation may be due to species difference, processing method and oil source formula used.

Table 3: Effect of Olive oil enriched on the Mono Unsaturated Fatty Acids (MUFA) of beef burger.

Treatments	Mono Unsaturated Fatty Acids (MUFA)			
	Palmitoleic C16:1	**Margaricolei c C17:1**	**Oleic C18:1**	**Eicosenoic C20:1**
0.0 %	3.56[a] (±0.31)	1.48[a] (±0.45)	34.86[a] (±6.18)	1.25[a] (±0.77)
0.5 %	3.61[a] (±0.44)	1.66[a] (±0.69)	35.86[a] (±7.81)	1.33[a] (±0.89)
1 %	3.76[a] (±0.44)	1.86[a] (±0.62)	38.51[a] (±8.04)	1.70[a] (±0.93)
1.5 %	3.86[a] (±0.34)	1.88[a] (±0.60)	39.89[a] (±5.59)	1.84[a] (±0.73)

Values are means ± SD.

Means in the same column bearing same superscript (small letters) are not significantly different (P≥0.05).

It was noticed that, the poly-unsaturated fatty acids increased as olive oil levels increased Table 4. Where the linoleic acid values of beef burger with different levels of olive oil (0%, 1.0%,1.5% and 2.0%) had showed following results (6.23mg/100g, 7.23mg/100g, 8.81mg/100g and 8.86mg/100g) respectively. Fajer *et al*., (2013) indicated that the diet supplemented with flaxseed (5% and 10%) had showed linoleic acid values of (11.63 mg/100g, and 12.27 mg/100g) respectively. Khaksar *et al* .,(2011), stated that, addition of carefully selected canola oil, can increase the linoleic acid from 22.03mg/100g at zero time to 22.64mg/100g after 30 days of storage. Pelser *et al.*, (2007) found that PUFA content increased with increased levels (3% to 6%) of flax oil in fermented sausages. For linolenic acid values, it was noticed that, the maximum linolenic C18:3 acid values (5.26mg/100g) were obtained when 2.0% olive oil was added. Faqir *et al.*,(2013) reported that, the supplemented diet by flaxseed at 0%, 5%,10% and 15%, had increased linolenic acid in broiler meat from 1.96mg/100g, 2.76mg/100g, 3.02mg/100g to 3.24mg/100g respectively.

Srinivassane (2011) mentioned that Alpha-linolenic acid (ALA) was found to increase in frankfurters with the increasing levels of flax oil (ranging from 0.8g to 1.7g/100g).

Beef burger treated with different concentrations of olive oil (1.0%, 1.5% and 2.0%) showed different values of Eicosadionic acid (C20:1) (1.33mg/100g, 1.46mg/100g and 1.66mg/100g) respectively. Fajer *et al*., (2013) reported that the Eicosadionic acid value of breast meat was 1.91mg/100g.

The ratio of PUFA/SFA, significantly increases with the enriched of burger with olive oil from 0.20mg/100g to 0.23mg/100g. Srinivassan (2011) reported that PUFA/SFA ratio of frankfurter was 0.99mg/100g, 1.19mg/100g and 1.31mg/100g for samples with 1.2%, 2.4% and 3.6% of fish oil respectively. HD, (1994), stated that PUFA/SFA ratio should be higher than 0.4. DH (2004), reported that n-6/n-3 PUFA ratio, should be 4-5 or less. Enser *et al.*, (2000) observed that linseed is an effective feed for increasing the oil content of pork meat and can improve the n-6/n-3 PUFA ratio. Srinivassan (2011) mentioned that the fatty acid profile of meat can be easily modified through enrichment and feeding, thereby improving the quality of meat for the consumer and meeting nutritionists' recommendation.

Table 4: Effect of Olive oil enriched on the Polyunsaturated Fatty Acids (PUFA) of beef burger.

Treatments	Polyunsaturated Fatty Acids (PUFA)			
	Linoleic acid C18:2	Linolenic acid C18:3	Eiccosadienoic acid C20:2	Ratio PUFA/SFA
0.0 %	6.23^{a} (±2.13)	3.62^{a} (±2.08)	2.24^{a} (±0.37)	0.21
1.0%	7.23^{a} (±3.97)	3.99^{a} (±2.60)	1.33^{a} (±0.57)	0.21
1.5%	8.61^{a} (±4.00)	4.40^{a} (±2.44)	1.46^{a} (±0.61)	0.22
2.0%	8.86^{a} (±3.27)	5.26^{a} (±1.89)	1.66^{a} (±0.36)	0.23

Values are means ± SD.

Means in the same column bearing same superscript (small letters) are not significantly different (P≥0.05.

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusion

Based on the results obtained in the present study, the following conclusions can be drawn

* The Peroxide Value (PV) of beef burger increased ($P<0.05$) with the increase of olive oil level.

* There were noticeable increases in peroxide value (PV) by storage period.

* As olive oil levels increased, the Saturated Fatty Acids (SFA) increased.

* Mono Unsaturated Fatty Acid (PUFA) increased with the increased of olive oil level.

Recommendations

- It is recommended that the usage of olive oil in meat products could enhance their quality characteristics and produce a healthy beef product.
- Further research is needed to study the amino acids and minerals of the new product.

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