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Effect of Fat Content on Quality and Storage Stability of Beef Shawarma

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ABSTRACT

This investigation was carried out to get more information on the effect of fat content on the characteristics and storage stability of beef Shawarma at refrigerated conditions. Four different formulations of beef Shawarma, free lamb fat (FFS), 5% low lamb fat (LFS), 10% medium lam fat (MFS) and 12% high lamb fat (HFS), were prepared, stored at 4°C after packaging in poly propylene pouches, and subjected for pH, TBA, objective colour measurements, bacteriological, and sensory analysis every 3 days. The results indicated that addition of lamb fat reduced pH, redness of colour, increased from TBA, lightness of colour, count of TVC, Psychrotrophic, Enterobacteriaceae and Coliform bacteria of Shawarma. It was also improved from the tasts and aroma acceptability, increased from colour lightness and softening of the texture of cooked Shawarma. During storage at 4°C for 12 days, a gradual lower in pH, lightness of colour, total acceptability, step wise rise in TBA, pale colour, softness of texture and load of determined bacteria of Shawarma were observed especially in products containing high fat.

Key Words: Shawarma, Lamb fat, Colour measurement, Sensory properties, pH, TBA, Bacteriological quality

INTRODUCTION

Meat and meat products are essential components of the human diet. They provide high quality protein, vitamins, and large amounts of essential metals such as iron (Jimenez-Colmenero et al., 2001). In other hand their high content of fat rich in saturated fatty acids and cholesterol may cause injurious to human health (Sylvia et al., 1994).

Production of low fat meat products to reduce lipids and their oxidation products such as free-radicals, malondialdehyde and cholesterol oxidation compounds improves their nutritional value and storage stability. (Jimenez-Colmenero, 2000). In other side, reduction of fat may influence the physicochemical properties and the sensory characteristics especially aroma of cooked meat. Since large amounts of volatile compounds are generated from lipid oxidation and their interaction with other food components (Mottram, 1998).

In Egypt, Shawarma is one of popular grilled spicy beef meat products. During it's preparation in a commercial scale, ~ 12-15% of saturated lamb fat is added to gain the grilled product pleasant flavour. Such addition may affect the nutritional quality, technological characteristics and storage stability of this product. Therefore, this investigation was carried out to get more information on the properties of Shawarma and to study the effect of fat content on it's characteristics and storage stability at refrigerated condition.

MATERIALS AND METHODS

Materials:- United State frozen imported back rip boneless beef, fresh lamb fat, Ultra High Temperature Sterilization (UHT) skimmed cow milk, spices blend (Cinnamon-white, red and black pepper, thyme, sage, nutmeg, rosemary, and Cardamom) of El-Motaheda. Co., fresh onion, refined fine iodized common salt, natural vinegar were obtained from the local markets of Alexandria city, Egypt. All reagents and chemicals used in this study were analytical grades

Methods:

1-Technological Methods:-

1.1- Manufacture of Shawarma:- Frozen meat was thawed at room temperature (22 ± 3°C) for 4-5 hrs., dressed by removing their surrounded fat layers, cut into 10 cm thickness portions then into small thin slices with 4-5 mm thickness using stainless steel knives, kept in stainless steel nets to separate blood, then well mixed with 6.7% chopped onions, 1% spices blend, 1% salt, 3.3% vinegar, 7% water, 6.6% UHT skimmed milk in bowl then stored at 4°C for 24 hrs. Lamb fat was trimmed to remove inedible parts, cut into small portions, chopped in meat mincer to pass through 3 mm before adding to cooled meat mixture. Depending on the content of meat in cold meat mixture, four different formulations of Shawarma containing free lamb fat Shawarma (FFS), 5% low fat Shawarma (LFS), 10% medium fat Shawarma (MFS), and 12% high fat

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Shawarma (HFS), were prepared. The prepared Shawarma was packed in poly propylene pouch, stored at 4°C and subjected for analysis every 3 days.

1.2- Cooking of Shawarma:- Raw product was cooked properly at 425°F (218 °C) for 6 min after spreading on the surface of hot clean moved grill.

2- Analytical methods:- The pH was determined using Testo pH meter, type 230, at room temperature (22 ± 3°C) as described in AOAC (2000). Thiobarbituric acid (TBA) was colourmetically estimated according to Park et al., (2007) using spectronic 601 Spectrophotometer and expressed as malonaldehyde absorbance per kilogram oil. Objective colour measurements of raw Shawarma was assayed as described by Mackinnery and Little (1962) using lovibond Schofield Tintometer. The obtained lovibond values were converted into CIE units, hue, purity and lightness, using the visual density graph and an instructions in manual supplied with apparatus.

3- Microbiological Methods:- Ten grams of Shawarma were blended with 90 ml of sterilized peptone water for 5 min in sterilized glass jar of a blender. Appropriate dilution was prepared for enumeration using standard microbiological pour plate technique and the recommended culture media of Oxoid (2002). Plate count agar medium was used for enumerating the Total Viable Count (TVC) and Psychrotrophic count (PC) bacteria after incubating at 35-37°C for 48 hrs. and 7°C for 10 days respectively. Violet red bile agar with methyl umbeliferyl glucouronide (VRB-MUG) selective media was used for isolating Coliform, gram negative enteric bacteria and rapid detection of *E. coli*. The propar dilution of the Shawarma homogenate was inoculated in sterile Petri dishes then medium was poured and plates were incubated at 37°C for 18-24 hrs. Colonies of lactose negative Enterobacteriaceae are colorless and those of lactose positive are red and often surround by a forbid zone due to precipitation of bile acids.Light blue fluorescent colonies under UV-Lamp (336 nm.) denote as *E. coli*. The recommended Difico Barid Parker Agar medium by ICMSF (1978) was used to detect *Staphylococcus aureus* after incubating the plates at 35-37°C for 48 hrs. The black shiny colonies with narrow white margin and surrounded by clear zones were counted as *Staphylococcus aureus*.

4- Organoleptic Methods:- Colour, texture, flavour and overall acceptability of cooked Shawarma were organoleptically evaluated using 10 trained panelists and 5 point scale ranging from 1 (Poor) to 5 (Excellent) as mentioned by El-Sahn, et al.,(1995).

5- Statistical Methods:- The standard devition was calculated using the method described by Steel and Torrie,(1980).

RESULTS AND DISCUSSION

1- Effect of fat content on pH:- As seen in Table (1), pH values of Shawarma free and containing lamb fat ranged from 6.31 to 6.53. The ingredients added to meat during Shawarma processing may be behind the slight rise of it's pH value. Addition of lamb fat lowered pH of Shawarma. This effect increased with increasing proportion of lamb fat in Shawarma formulation. This may be due to the free fatty acids in lamb fat. Also extending storage period at 4°C led to a gradual lower in pH of Shawarma especially product containing high fat content. Such pH changes may be due to the lipolytic hydrolysis of fat resulting from the slow growth of lipolytic organisms during storage of Shawarma at 4°C. At the end of storage period, 12 days at 4°C, pH value of Shawarma differed from 5.26-5.9. According to Devine and Chrystall (1992), pH of fresh meat varied from 5.9 to 6.2. Abd El-Aziz et al., (2012) showed that the thawed frozen beef meat had 5.91-5.96 pH value.

2- Effect of fat content on TBA:- Oxidation stability of Shawarma free and containing lamb fat during storage at 4°C was estimated by measuring TBA. Lipid content and structure are significantly affected lipid oxidation (Estevez et al., 2005). Results in Table (1) showed that TBA value of Shawarma products before storing ranged from 0.03 to 0.07 malonaldehyde absorbance/kg. It was relatively higher in products containing lamb fat. Also, it was increased with increasing level of the addition of lamb fat in the product. Generally slight rises in TBA values was noticed with extending the storage period at 4°C of Shawarma products, free and containing different levels of lamb fat. Because the lamb fat contains high ratio of saturated triglycerides and Shawarma products stored at 4°C in a refrigerator inside polypropylene bags, far from oxygen and light, the rate of it's oxidation was limited. This may be behind the low resulted values of TBA of Shawarma products. Estevez et al., (2005), attributed the presence of high values of TBA in liver pates to lipid oxidation. They found significant correlation between fat content and lipid oxidation.

3- Effect of fat content on colour:- It is known that colour of food is closely related to the colour characteristics of the raw materials used for it's preparation. Therefore changes in the proportion of the ingredients might lead to different colour characteristics. Results in Table (2) indicated that fat content affected the colour of Shawarma. HFS had higher colour lightness or brightness and lower colour redness than FFS, LFS and MFS. FFS was redder, with slightly more chrome or intense colour and relatively lower values of hue when compared with HFS.

Table 1. Effect of fat content on pH and TBA of Shawarma during storage at 4°C

Shawarma	FFS*		LFS*		MFS*		HFS*	
Storage period (day)	pH	TBA	pH	TBA	pH	TBA	pH	TBA
0.0	6.53 ± 0.01	0.03 ± 0.007	6.41 ± 0.04	0.05 ± 0.006	6.32 ± 0.02	0.05 ± 0.005	6.32 ± 0.01	0.07 ± 0.005
4	6.37 ± 0.04	0.05 ± 0.006	6.06 ± 0.03	0.05± 0.007	5.98 ± 0.01	0.07 ± 0.005	5.92 ± 0.03	0.09 ± 0.006
8.0	6.31 ± 0.02	0.05 ± 0.005	6.06 ± 0.02	0.07 ± 0.005	5.72 ± 0.02	0.08 ± 0.003	5.42 ± 0.02	0.11 ± 0.007
12	5.96 ± 0.02	0.07 ± 0.003	5.90 ± 0.02	0.07 ± 0.003	5.48 ± 0.02	0.09 ± 0.007	5.26 ± 0.02	0.14 ± 0.005

*FFS = Free Fat Shawarma *LFS = Low Fat Shawarma
* MFS = Medium Fat Shawarma *HFS = High Fat Shawarma

Table 2. Effect of fat content on colour measurements of Shawarma during storage at 4°C

Shawarma	FFS*				LFS*				MFS*				HFS*			
Storage period (day)	0.0	4	8	12	0.0	4	8	12	0.0	4	8	12	0.0	4	8	12
Properties																
Red (R)	9.9	8.9	8.9	8.7	8.4	8.5	8.3	8.3	8.0	8.4	8.3	8.2	7.9	7.7	7.6	7.3
Yellow (Y)	9.0	9.9	9.9	9.9	9.0	9.5	9.7	9.9	9.5	9.9	9.9	9.9	9.9	9.9	9.9	9.9
Dominant colour	0.9 (R)	1 (Y)	1 (Y)	1.2 (Y)	0.6 (R)	1 (Y)	1.4 (Y)	1.6 (Y)	1.5 (Y)	1.5 (Y)	1.6 (Y)	1.7 (Y)	2.0 (Y)	2.2 (Y)	2.3 (Y)	2.6 (Y)
Hue (h)	590	588	588	588	589	588	587	587	589	588	587	587	588	587	586	586
Purity chroma	0.69	0.67	0.67	0.67	0.70	0.68	0.69	0.69	0.73	0.71	0.70	0.69	0.70	0.76	0.76	0.70
Visual density values	0.42	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.41
Brightness or lightness	373	372	371	370	375	371	373	371	376	375	373	371	384	383	382	382

*FFS = Free fat Shawarma * LFS = Low fat Shawarma
* MFS = Medium fat Shawarma * HFS = High fat Shawarma

Table 3. Effect of fat content on bacteriological quality of Shawarma during storage at 4°C

Shawarma	FFS*				LFS*				MFS*				HFS*			
Storage period (day)	0.0	4	8	12	0.0	4	8	12	0.0	4	8	12	0.0	4	8	12
Bacterial type																
TVC	$3.9x10^3$	$3.3x10^4$	$6.0x10^4$	$8.2x10^6$	$5.1x10^4$	$4.8x10^5$	$7.2x10^5$	$6.5x10^6$	$8.3x10^5$	$8.7x10^5$	$9.0x10^5$	$3.8x10^6$	$7.5x10^5$	$9.0x10^5$	$3.2x10^6$	$5.3x10^7$
Psychrotophic	$5.1x10^2$	N.D	N.D	N.D.	$5.3x10^4$	$3.0x10^3$	N.D	$4.1x10^3$	$6.9x10^4$	$3.0x10^3$	N.D	$3.0x10^4$	$4.7x10^4$	$7.9x10^4$	$8.2x10^4$	$3.7x10^5$
Enterobacteriaceae	$3.4x10^3$	$3.9x10^3$	$6.0x10^3$	$4.3x10^4$	$3.0x10^4$	$3.2x10^4$	$3.8x10^4$	$4.4x10^4$	$6.5x10^4$	$3.3x10^5$	$3.6x10^5$	$3.7x10^5$	$4.7x10^4$	$4.5x10^5$	$5.7x10^5$	$6.6x10^5$
Coliform	$9.5x10^2$	Not determined	$4.0x10^3$	$5.0x10^3$	$5.0x10^3$	$6.0x10^3$	$8.0x10^3$	$9.0x10^3$	$3.0x10^3$	$3.9x10^3$	$8.9x10^3$	$9.0x10^3$	$5.0x10^3$	$5.9x10^3$	$1.5x10^4$	$3.0x10^4$

N.D. = Not Detected

* FFS = Free Fat Shawarma *LFS = Low Fat Shawarma

* MFS = Medium Fat Shawarma *HFS = High Fat Shawarma

Table 4. Effect of fat content on sensory properties of cooked Shawarma after storage at 4°C for different periods

Shawarma	FFS*				LFS*				MFS*				HFS*			
Storage period(day)	0.0	4	8	12	0.0	4	8	12	0.0	4	8	12	0.0	4	8	12
Colour	4	4	3	3	4	4	3	3	4	4	3	3	3	3	3	2
Taste	3	3	3	3	3	3	3	3	4	4	3	3	4	4	3	2
Odour	3	3	3	3	3	3	3	3	4	4	3	3	4	4	3	2
Texture	4	3	3	3	4	4	3	3	4	4	3	3	3	3	2	2
Acceptability	3	3	3	3	3	3	3	3	4	4	3	3	3	3	3	2

* FFS = Free Fat Shawarma * LFS = Low Fat Shawarma
*MFS = Medium Fat Shawarma * HFS = High Fat Shawarma

Extending storage at 4°C increased from the pale colour, reduced lightness, caused slight changes in purity, visual density and hue of Shawarma. The previous changes were more observed in products containing lamb fat particularly HFS.

4- Effect of fat content on bacteriological quality:- Bacterial spoilage is one of the major attributes that used to measure the change in meat quality during processing and storage. Data in Table (3) showed that the Total Viable Count (TVC) varied from 3.3×10^4 to 9×10^5 cfu/g in Shawarma. It was higher in HFS than FFS and LFS before storage. This is an indication that the rise of TVC in product due to the lamb fat addition. Generally, this count was less than 10^6 cfu/g stated in the Egyptian Standards (1522/2005) for meat and meat products.

The results in the same table were also indicated that the count of psychrotrophilic bacteria, Enterobacteriaceae and Coliform ranged from 5.1×10^2 to 6.9×10^4, 3.4×10^3 to 3.3×10^5, and 9.5×10^2 to 9.0×10^3 cfu/g respectively. As mentioned before the count of these organisms was higher in products containing lamb fat and increased with increasing the proportion of fat addition. This was also led to rise the count of most of the determined bacteria in lamb fat containing products during storage at 4°C with higher rate than FFS. Both of *E. coli* and *Staphylococcus aureus* did not detect in raw and stored Shawarma The load of TVC bacteria in HFS was more than 10^6 and 10^7 cfu/g after 8 and 12 days of storage at 4°C respectively. In other Shawarma products including free fat one the load of TVC was more than 10^6 in the end of storage, 12 days. According to Jay (1986) spoilage occurs when bacterial load reach 10^7cfu / g in the meat. This means that the storage period at 4°C of HFS was less 4 days comparing with FFS, LFS and MFS.

Psychrotrophic bacteria was detected in low count in FFS and disappeared during storage at 4°C for 12 days. In contrast, the load of this bacteria was fluctuated during storage of Shawarma containing lamb fats. It was nearly stable after 4 days, not detected after 8 days, and re-detected after 12 days of storage at 4°C for LFS and MFS. Meanwhile, slight changes in the count of this bacteria was noticed after 8 days of storage and an increase in it's load was occurred after 12 days in HFS. Psychrotrophic bacteria grow at refrigerated temperatures but achieve optimum growth at > 20°C. During storage of meat at refrigerated temperatures, the load of this bacteria are increased and their metabolites cause off odour and colour components. (Bailey, et al., 1992).

Both Enterobacteriaceae and Coliform were detected in all Shawarma products. The load of such bacteria was higher in fresh and stored HFS than FFS. Slight rise in the count of these types of bacteria was observed with extending storage period at 4°C. This may be due to their sensitivity to low temperature. Shawarma products were free from *E. coli. Staphylococcus aureus* was only detected in Shawarma containing lamb fat after 12 days of storage at 4°C, in a count ranged from $2.2\text{-}3.4\times10^2$ cfu/g. The above results confirmed that lamb fat is considered the main source of bacterial contamination of Shawarma inaddition to poor hygienic practices followed during Shawarma preparing. Therefore microbiological quality of lamb fat and hygienic practices are needed to revise.

5- Effect of fat content on organoleptic properties:- Reduction of fat in Shawarma might affect it's sensory characteristics after cooking. Results in Table (4) demonstrated that fat has been influenced palatability and aroma characteristics of cooked Shawarma. The acceptability of taste and aroma of HFS and MFS were described by panelists as good. Heating of such products generates volatile compounds from fat. In contrast presence of high fat gave Shawarma with soft texture less firm and more juicy as described by panelists. Also panelists showed that the colour of HFS and MFS was more lighter than of LFS and FFS. According to the previous observations of panelists, the total acceptability of Shawarma followed the following order, LFS > MFS > FFS > HFS. Generally the acceptability of Shawarma products reduced with

extending storage period at 4°C. This reduction was more noticeable after 12 days particularly in HFS, Table (4). Estevez et al., (2005) stated that the equilibrium between generation and release of volatile compounds in liver pates may influence sensory perception of the aroma by consumers.

CONCLUSION

Fat content affected the quality and storage stability of Shawarma. Raw HFS had less red colour, lower pH, relatively higher TBA, and load of all determined bacteria and short storage period at 4°C than FFS, LFS and MFS. In contrast increasing fat content increased from flavour characteristics especially odour, colour lightness and softness of texture of cooked Shawarma. Panelists preferred the sensory properties of cooked LFS than other Shawarma product.

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الملخص العربي

تأثير محتوي الدهن علي جودة والثبات التخزيني لشاورما اللحم البقري

نادية احمد عبد العزيز

تم إجراء هذه الدراسة للحصول علي معلومات أكثر عن تأثير محتوي الدهن علي خواص والثبات التخزيني لشاورما اللحم البقري تحت ظروف الحفظ بالتبريد٠ تم إعداد أربعة مخاليط من شاورما اللحم البقري خالية من ومضاف اليها ٥، ١٠، ١٢% من دهن الأغنام تم التخزين بعد التعبئة في أكياس من البولي بروبولين علي ٤°م واجراء تحليل لكل من رقم الحموضة(pH)، والـ TBA، ومقاييس اللون الكمية والعد البكتيري والخواص الحسية كل ٣ أيام٠ وقد حدث انخفاض في رقم الحموضة ودرجة احمرار اللون وزيادة في قيم الـ TBA ودرجة ضياء اللون والعد الكلي لكل من TVC والبكتريا المحبة للحرارة المنخفضة والـ Enterobacteriaceae والـ Coliform مع زيادة اضافة نسبة الدهن وأدي أيضا إرتفاع نسبة الدهن الي تحسين درجة تقبل كل من رائحة وطعم وزيادة درجة ضياء اللون وطراوة القوام للشـاورما المطبوخة وسبب التخزين علي ٤°م لمدة ١٢ يوم إلي إنخفاض تدريجي لرقم الحموضة،ضياء اللون،التقبل الكلي، وإرتفاع متدرج في رقم TBA وشحوب اللون وطراوة القوام والعد الكلي لأنواع البكتريا المقدرة للشاورما خاصة المرتفعة في محتواها من الدهن٠