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Overview on the rancidity detection in common sandwiches of chicken products

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ABSTRACT

Eighty random samples of fast food chicken sandwiches were randomly collected from Egypt market. Sandwiches of burger, shawerma, liver and pane (20 of each) were purchased from different street vendors and restaurants. Sensory evaluation and chemical analysis were performed on the collected samples to determine rancidity on extracted fats and total polar materials. The results revealed that all samples examined were acceptable in sensory characters. The peroxide values of extracted fats in the examined chicken samples (burger, shawerma, liver and pane sandwiches ranged from (1.38, 0.644, 0.828 and 0.64) to (11.05, 10.77, 11.78 and 10.16) mg equivalent oxygen/kg respectively. While, acidity % of extracted fats in the examined chicken samples (burger, shawerma, liver and pane sandwiches ranged from (0.219, 0.244, 0.28 and 0.25) to (0.857, 0.769, 0.78 and 0.85) mg equivalent oxygen/kg respectively. In addition, thiobarbituric acid in the examined chicken samples (burger, shawerma, liver and chicken pane sandwiches ranged from (0.44, 0.44, 0.44 and 0.468) to (2.523, 2.34, 1.52 and 1.287) mg malonaldehyde/kg respectively. While, total polar materials in the examined chicken samples (burger, shawerma, liver and pane sandwiches ranged from (10, 22, 22 and 22) to (44, 41, 60 and 56 %) respectively. Even though the sensory character accepted in all examined samples, rancidity condition detected in a lot of samples examined

INTRODUCTION:

In Egypt, chicken occupy the major role in production and consumption among poultry. Chickens are more commonly found than any other food animal, making them a primary source of dietary protein for people worldwide. After red meat, chicken is the second most widely consumed meat. Its popularity is due to its ease of preparation, consistent quality, and the wide variety of raw, ready-to-eat, and fried products available **(Shedeed, 1999).**

Frying, one of the most ancient cooking practices, is characterized by the concurrent transfer of heat and mass. It gives fried foods distinctive flavors, aromas, and textures that are hard to achieve with other cooking tech-

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niques. Because frying is done at relatively high temperatures (150–180°C), chemical reactions such as hydrolysis, oxidation, polymerization, and pyrolysis happen quickly in the triglycerides **(Aladedunye, 2015)**

The oxidative stability of fats and oils is crucial in determining the quality of products that contain lipids. Even foods with very low lipid content (as little level as 51%) are prone to oxidation, which leads to rancidity. This oxidation not only shortens the shelf life of foods but also produces compounds that negatively affect their quality. Additionally, these oxidation products can pose health risks, as they have been linked to the development of various diseases **(Wsowicz et al. 2004).** Research has also shown that lipid oxidation products may contribute to serious health issues such as atherosclerosis, Alzheimer's disease, cancer, inflammation, and the aging process **(Broncano et al. 2009).**

Exposure of cooking oils to high temperatures induces oxidative and hydrolytic reactions, such as hydrolysis, cyclization, or polymerization. These reactions result in significant chemical and physical changes, producing a variety of volatile and non-volatile decomposition products **(Friedman, 2000).**

Moreover, the nature and quantity of these decomposition products are influenced by various factors, such as the type of food being fried and the kind of fat used, the fryer design, and operating conditions such as temperature, oxygen exposure, heating duration, and turnover rate. Most of the non-volatile by-products are grouped under total polar materials (TPM). These TPM components consist of dimeric fatty acids, triglyceride monohydroperoxides, polymerized triglycerides (PTG), cyclic fatty acid monomers, and aldehydic triglycerides **(Gertz, 2000)**

Several fast methods are now available for measuring the degree of oxidation in frying oils by examining their sensory and chemical characteristics. These include measuring acidity, peroxide levels, thiobarbituric acid values, and total polar materials, which together provide a reliable indication of oil degradation **(Bansel et al. 2010).**

The present research aims to discuss the health importance of the rancidity of some ready-to-eat chicken sandwiches, study the extent of rancidity and spoilage of the oils used in cooking, and clarify the least harmful.

MATERIALS and METHODS

collection of samples:

Eighty random chicken samples collected from street vendors and Egyptian restaurant (burger, shawerma, liver and pane sandwiches) 20 for each.

Sensory evaluation:

Sensory attributes for color, odour and taste were examined according to the scheme adopted by (**ISO, 16779:2015)** using the 5-point assessment score according to the following scheme: 1= very bad, 2= bad, 3 = accepted, 4= very good and 5= excellent.

Extraction of fat (FAO, 1986)

After sensory examination the sandwich samples were dried in hot air oven for 1 hr at 105 C, then the all fat present in the samples were extracted using petroleum ether (Piochem).

Determination of Peroxide values (AOAC, 2016)

Measurement of peroxide value on extracted fat was based on method described by AOAC, 2016 official method 965.33

Determination of acidity: (ISO 660:2020)

Determination of acidity on extracted fat was according to method described by (ISO 660:2020).

Determination of thiobarbituric acid: (ES 63 -10/2006)

Determination of TBA was according to method described by ES, 2006

Determination of total polar materials.

Determination of total polar materials on extracted fat using testo 270 cooking oil tester

RESULTS

Table 1. Acceptability and results of overall sensory evaluation (color taste, odour) in the examined chicken sandwiches samples:

Examined products		N0. of sample analyzed	Min.	Max.	Mean ±SE	accepted samples According to sensory grades	
						No.	%
Chicken burger sand-wic h	Taste	20	2	4	3.35 ± 0.17	20	100
	Color	20	2	5	3.45 ± 0.15	20	100
	Odour	20	3	5	3.8 ± 0.14	20	100
	overall	20	3	4	3.53 ± 0.08	20	100
Chicken Shawer ma sandwic h	Taste	20	3	4	3.50 ± 0.11	20	100
	Color	20	3	5	3.85 ± 0.108	20	100
	Odour	20	3	5	4.0 ± 0.12	20	100
	overall	20	3	4.33	3.78 ± 0.08	20	100
Chicken liver sand-wic h	Taste	20	3	4	3.55 ± 0.11	20	100
	Color	20	3	5	3.85 ± 0.10	20	100
	Odour	20	3	5	3.95 ± 0.11	20	100
	overall	20	3	4	3.78 ± 0.07	20	100
Chicken pane sand-wic h	Taste	20	3	3	3.60 ± 0.11	20	100
	Color	20	3	5	3.90 ± 0.11	20	100
	Odour	20	3	5	3.95 ± 0.11	20	100
	overall	20	3	4	3.81 ± 0.08	20	100

1= very bad, 2= bad , 3= accepted, 4= good, 5= very good

Table 2. Acceptability and results of peroxide values (mg equivalent oxygen /kg) in the examined chick-en sandwiches samples:

Examined products	N0. of sam-ple analyzed	Min.	Max.	Mean ±SE	Un accepted samples	
					No.	%
Chicken burger sandwich	20	1.38	11.05	4.56 ± 0.67	3	15
Chicken shawerma sandwich	20	0.644	10.77	4.47±0.64	3	15
Chicken liver sandwich	20	0.828	11.78	4.94±0.77	3	15
Chicken pane sandwich	20	0.64	10.16	4.44±0.60	1	5

Table 3. Acceptability and results of acidity % (as oelic acid) in the examined chicken sandwiches samples

Examined products	No. of sample analyzed	Min.	Max.	Mean ±SE	Un accepted samples	
					No.	%
Chicken burger sandwich	20	0.219	0.857	0.49±0.04	5	25
Chicken shawerma sandwich	20	0.244	0.769	0.47±0.04	6	30
Chicken liver sandwich	20	0.28	0.78	0.49±0.034	4	20
Chicken pane sandwich	20	0.25	0.85	0.52±0.05	6	30

Table 4. Acceptability and results of thiobarbituric acid values (mg malonaldehyde /kg) in the examined chicken sandwiches samples:

Examined products	No. of sample analyzed	Min.	Max.	Mean ±SE	Un accepted samples	
					No.	%
Chicken burger sandwich	20	0.44	2.535	1.11±0.1	12	60
Chicken shawerma sandwich	20	0.44	2.34	1.07±0.09	13	65
Chicken liver sandwich	20	0.44	1.52	0.898± 0.06	10	50
Chicken pane sandwich	20	0.468	1.287	0.90±0.05	10	50

Table 5. Acceptability and results of total polar materials % in the examined chicken sandwiches samples:

Examined products	No. of sample analyzed	Min.	Max.	Mean ±SE	Un accepted samples	
					No.	%
Chicken burger sandwich	20	10	44	26.2±1.92	12	60
Chicken shawerma sandwich	20	22	41	34.3±1.31	19	95
Chicken liver sandwich	20	22	60	35.57±2.25	18	90
Chicken pane sandwich	20	22	56	35.5±2.14	17	85

DISCUSSION

Foods containing lipids, even in very small amounts, are vulnerable to oxidation, which leads to rancidity. This lipid oxidation shortens the shelf life of food and can produce end-products that negatively affect its quality. Additionally, these oxidation products may pose health risks, as they have been linked to the development of various diseases. In particular, some advanced lipid oxidation products are known to promote inflammation, fibrosis, and abnormal cell growth **(Wsowicz et al. 2004; Kanner, 2007)**

The results presented in table (1) showed that the overall score of sensory evaluation including color, taste and odor in the examined chicken samples (burger, shawerma, liver and pane sandwiches ranged from (3, 3, 3 and 3) to (4,4.33, 4 and 4) with mean values (3.53 ± 0.08, 3.78 ± .08, 3.78± 0.07 and 3.81 ± 0.08) respectively. The high acceptable condition having 5 score while the very bad condition and not acceptable having 1 score. All examined chicken sandwich samples were accepted in sensory character. The acceptable sensory character could be attributed due to addition of some additives and flavors during cooking. this result was similar to result demonstrated by (**El-Dashlouty el al. 2015** and **El- Fakhrany et al. 2019)** who revealed that none of sandwiches tested were rejected

When cooking oils are exposed to heat, they undergo oxidative and hydrolytic reactions such as hydrolysis, cyclisation, and polymerisation. These chemical and physical changes lead to the formation of a variety of breakdown products, which can include both volatile and non-volatile compounds **(Friedman, 2000)**

Furthermore, the data displayed in Table (2) indicated that peroxide values of extracted fats in the examined chicken samples (burger, shawerma, liver and pane sandwiches ranged from (1.38, 0.644, 0.828 and 0.64) to (11.05, 10.77,11.78 and 10.16) with mean values (4.56 ± 0.67, 4.47 ± 0.64, 4.94 ± 0.77 and4.44 ± 0.60 mg equivalent oxygen/kg) respectively. In addition, 15 %, 15%, 15% and 5% of examined chicken burger shawerma, chicken liver and pane sandwiches, respectively were exceed the permissible limit of peroxide values of neamed edible vegetable oils set by (**ES 7985/2021)** and edible oil for frying set by (**ES 2142/2005)** (10 mg equivalent oxygen/kg) The findings closely matched the results that were shown by (**Nayak et al. 2016)** who demonstrated that the P.V of examined cooking oils ranged from 3.18 to 10 ml eq.o/kg. while, lower than results demonstrated by (**Rahimzadeh et al. 2014)** who mention that PV in frying oil show that 58% of heated oils in restaurants and 97% of the sandwich oils had higher peroxide concentration than standards. In addition the results were higher than results demonstrated by (**Danowska-oziewicz, et al. 2005)** who revealed that P.V of examined frying heated oils ranged from 0.09 to 0.11 mg eq.o/kg .

Moreover, the results presented in table (3) showed that acidity % of extracted fats in the examined chicken samples (burger, shawerma, liver and pane sandwiches ranged from (0.219, 0.244, 0.28 and 0.25) to (0.857, 0.769, 0.78and 0.85) with mean values (0.49 ± 0.04, 0.47 ± 0.04, 0.49 ± 0.034 and 0.52 ±0.05 mg equivalent oxygen/kg) respectively. In addition, 25 %, 30%, 20% and 30% of examined chicken sandwiches for chicken burger sandwich, chicken shawerma sandwich, chicken liver sandwich and chicken pane, respectively were exceed the permissible limit of acidity % of neamed edible vegetable oils set by (**ES 7985/2021)** and edible oil for frying set by (**ES 2142/2005)** (0.6% as oelic acid)

The results were higher than results demonstrated by (**Rahimzadeh et al. 2014)** who mention that the mean value of acidity in frying oil was 0.069 % and (**Danowska oziewicz, et al. 2005)** who revealed that the acidity of examined frying heated oils ranged from 0.11 to 0.3 mg eq.o/kg. While, lower than result demonstrated by (**Nayak et al. 2016)** who revealed that the acidity % of examined cooking oils ranged from 1.15 to 6.6 % as oelic acid.

Thiobarbituric acid (TBA) test has been used for measuring oxidative rancidity in fat containing food. The TBA test is sensitive in determining the decomposition of products of highly unsaturated fatty acids Oxidative deterioration results in losing the quality of meat cuts-up as well as rancid odor and taste **(Akoh, 2017)**

The results presented in table (4) showed that thiobarbituric acid in the examined chicken samples (burger, shawerma, liver and pane sandwiches ranged from (0.44, 0.44, 0.44 and 0.468) to (2.523, 2.34, 1.52 and 1.287) withmean values (1.11 ± 0.1, 1.07 ± .09, 0.898 ± 0.06 and 0.90 ± 0.05 mgmalonaldehyde/kg) respectively. In addition, 60 %, 65%, 50% and 50% of examined chicken sandwiches for burger, shawerma, liver and pane respectively, were exceed the permissible limit of thiobarbituric acid of products of the meat poultry treated with heat set by **(ES 3493/2005)** (0.9 mg malonaldehyde/kg)

The results demonstrated were nearly close to results demonstrated by (**Hendawy et al. 2017)** the TBA in examined products was around 0.71 mg mal/kg. While, higher than results demonstrated by **(Hejazy et al. 2020)** who revealed that the TBA in examined frying products ranged from .03 to 0.160 mg mal/kg. In addition, the results were lower than results demonstrated by **(El-Fakhrany et al. 2019)** who collected 66 random samples of fast food sandwiches. The thiobarbituric acid (mg MDA/Kg) were recorded in a range from 3.67 to 7.96 mg mal/kg

The high % of unacceptable samples could be attributed to the use of rancid oil in prepared sandwiches, improper handling and high level of unsaturated fatty acid that react with molecular oxygen leading to degredation of lipids and develop of malonaldehyde

In addition, the results presented in table (5) showed that total polar materials in the examined chicken samples (burger, shawerma, liver and pane sandwiches ranged from (10, 22, 22 and 22) to (44, 41, 60 and 56) with mean values (26.2 ± 1.92%, 34.3 ± 1.31%, 35.57± 2.25% and 35.5 ± 2.14%)

respectively. In addition, 60 %, 95%, 90% and 85% of examined chicken sandwiches for burger, shawerma, liver and pane, respectively were exceed the permissible limit of total polar materials of oils used in frying set by (**NFSA decree 1/2023)** (25%) These levels vary from one country to another for example France, Germany, and America adapted the guideline of 24% TPM; Italy, Belgium, Turkey, Spain, Thailand, and Brazil have 25% TPM **(Song et al. 2017)**

These findings were greater than those demonstrated by **(Mlček, et al. 2015),** who noted that the mean values for TPM were below 20% for all types of oils and fats used for frying in 46 restaurant samples. Additionally, the results also exceeded those reported by (**Song et al. 2017),** who noted TPM were 24.7 % in examined oils used in chicken frying. While, our results were nearly close to results revealed by (**Andrikopoulos et al. 2003)** who mentioned in their papers that the TPM is reaches 40% of examined oils and fat used in frying

The high % of unacceptable samples indicate using frying oils for long times. The quality of frying oil can be evaluated by measuring the levels of polar compounds and polymers it contains.

There are many factors that impact the amount of total polar content in frying oils and fats. For example, the fatty acid composition of oil has marked effects on its frying performance as well as on its physical and chemical behavior. The formation of polar compounds during repeated frying operations has been shown to increase with the degree of oil unsaturation **(Brinkmann, 2000).**

Another important factor affecting the formation of polar compounds in heated oils is the ratio of the oil's surface area to its volume in the fryer. The specific surface area is crucial in determining oil behavior during frying because oxidation, rather than direct contact with the food, is the primary cause of oil degradation, as stated by (**Bracoo et al. 1981).** Another key factor is temperature; it is recommended that frying be carried out within the range of 160 to 180°C. **Soriano et al. (2002)** reported that the rate of oxidative deterioration, measured by the formation of total polar materials (TPM), increased much more rapidly when frying at 215°C compared to 185°C

Based on the results obtained in this study, it can be concluded that even though the acceptable sensory character in fasting foods, rancidity character that lead to public health hazard could be appeared. Implementing good manufacturing practices and improving environmental controls through GMP, under the supervision of Egyptian authorities, can help reduce or eliminate these conditions

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