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Food safety assessment for fried meat and fish ball in Ninh Kieu district, Can Tho city

Huynh Thi Phuong Loan*, Do Thi Anh Thu, Nguyen Thi Thanh Tuyen, Le Nguyen Bao Ngoc, Nguyen Que Tran

Institute of Food and Biotechnology, Can Tho University, Can Tho, Vietnam

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Abstract

The study aims to evaluate the degree of fat oxidation and the reuse of fried oils in fried meat and fish ball products sold in Ninh Kieu District, Can Tho City. The fat content was determined in fried products, as follows: fish balls (15 - 21%), beef balls (11 -14 %), and shrimp balls (15 - 23%). Because of the difference in the fat origin of the three types of fried products, the oxidation levels of these products are also different; therefore, this is possible through parameters related to the variation of fat such as acid index, peroxide index, malondialdehyde (MDA) content. The concentration of MDA was the highest in fried fish balls, and the lowest value was in beef balls. After surveying for five consecutive days, the highest concentration of MDA in fried products was obtained in the last days of the cycle (4th day). The acid value in the fried oil samples ranges from 0 - 1 mg, the peroxide index from 2 - 5.78 meq/kg, and the concentration of MDA ranges from 0.22 - 2.98 µmol/L. A combination of results of the degree of fat oxidation in fried meat and fish ball products and frying oils indicates that the sellers reused the oils and tended to renew them every 3 - 4 days.

Keywords: *Fried meat, fish ball, fat oxidation, fry oil, food safety.*

1. INTRODUCTION

These days, the demand for fast foods and convenient meals has become a popular trend among young people. Carts, street vendors with food products made on the spot, such as fried fish balls, fried beef balls, shrimp balls, sausage, etc with all kinds of attractive shapes and colors sold in crowded places or on the main road in Ninh Kieu district, Can Tho city. Most fried products sold on the street have no clear origin, so it is difficult for consumers to assess product quality as well as issues related to food hygiene and safety. Existing in this product group is the quality hazard of fried oil because fat is heated at a high temperature or reused many times will produce toxic substances that affect consumer health

* *Corresponding author: 0907713277* *Email: htploan@ctu.edu.vn*

such as peroxide, malondialdehyde (MDA), acrolein, acrylamide, causing chronic diseases like cardiovascular disease, blood pressure, and cancers, especially rectal cancer, liver cancer, lung cancer, breast cancer, etc [1].

This study was implemented to provide basis information for the management of the safety and hygiene of fried meat and fish balls. To evaluate the degree of fat oxidation in fried fish meat products sold in Ninh Kieu district, Can Tho City, the research objective is to analyze the total lipid content, the acid value, and the total lipid content, peroxide value, and MDA content in fried products (fish balls, beef balls, shrimp balls) and fried oil.

The research results aim to provide information and reflect the current situation of food safety and hygiene of fried meatballs and fish balls in Ninh Kieu district, Can Tho city, thereby helping consumers to protect the health of themselves, their families, and the community when choosing to use these products.

2. MATERIALS AND RESEARCH METHODS

2.1. Research object

Collected samples included 03 main products: fish, beef and shrimp balls and fried oil, these samples are sold at 9 popular places specializing in selling fried meat and fish balls, located on the main roads of Ninh Kieu district, Can Tho city (numbered from 1 to 9). These streets were 3/2, Le Loi, Ben Ninh Kieu, Nguyen Van Cu, 30/4, Tran Phu.

Sampling time at 1 vender was extended for 5 consecutive days to determine the time of changing oil used for frying. The calculated sample size was according to the descriptive cross-sectional research method [2].

Apply the formula to estimate a proportion in a population:

$$n = \frac{Z^2 p\ (1-p)}{c^2}$$

In which:

n is the smallest reasonable sample size;

Z is the value depending on the desired confidence level of the estimate; choose the desired confidence level of 95%, then Z = 1.96;

p: is the estimate of the unknown parameter p of the population; The research team carried out a preliminary survey on the degree of oxidation of fats in fried products and fried oils sold in street vendors, showing the degree of oxidation of fried products and frying oils in about 10%, so p = 0.1;

c: is the precision of the study, is the difference between the proportion of p obtained in the sample and the proportion of true p in the population; This difference was chosen by the researcher as 0.05.

According to the calculation formula, the smallest sample size will be: 138, so the study collected 143 samples, including 135 samples of fried products (including fried fish, beef, and shrimp balls) and 08 samples of fried oil.

2.2. Research Methods

2.2.1. Sampling method

Samples are encoded with symbols and stored information including sample code and sampling location. Next, we transferred to the laboratory. The samples were stored at 5°C and analyzed for the following parameters: total lipid content, acid value, peroxide value, and MDA content.

2.2.2. Analytical methods

Total lipid content: Determination of total lipid content - Distillation method in organic solvents according to TCVN 3703:2009 [3]. 10 g of the prepared test sample was weighed (to the nearest 0.001 g) into a porcelain mortar and ground with about 20 - 30 g of anhydrous sodium sulfate or anhydrous calcium sulfate to obtain a dry powder mixture. At the next stage, all the resulting mixture was transferred to a cylindrical filter paper package with a diameter of 2 cm, sealed at one end, wiped the porcelain mortar was with ether and then put in a paper tube, then sealed the end, the sample pack was placed into the extraction tube of the apparatus and then connected to the flask below (the mass is known in advance). This is followed by placing the ether in the extraction flask so that only the sample pack tube is submerged. After being placed, the sample was soaked in the ether for 3 - 4 h or overnight. After the sample soaking time, the condenser tube was raised and added enough ether to the extraction flask to flow down the flask. Next, we waited for the ether to drain completely, then added ether until about half the height of the siphon. Once this stage is completed, the condenser was inserted and let cold water run through. Next, we distilled in a water bath for about 10 - 12 h. After the distillation time, when the solvent was drained completely into the flask, then stopped heating, let cool, then removed the condenser tube and the sample pack were from the extraction vessel. In the following stage, the flask was placed in the drying oven and dried at 50 - 60°C for 30 - 40 minutes. Then, the flask was placed in the desiccator for 30 minutes and weighed to the nearest 0.001 g. Repeat the above operation until the mass of the flask remains unchanged. The mass of fat is calculated by subtracting the mass of the flask containing the dried fat from the mass of the flask containing the dried fat.

Acid value: Determination of acid value - Cold solvent method using an indicator (Standard method) according to TCVN 6127: 2010 [4]. 5 g of fat was weighed into a 250 mL conical flask, added 50 mL of the neutralized solvent mixture (ethanol and diethyl ether), continued to added 3 drops of phenolphthalein indicator, and titrated with potassium hydroxide standard solution to when a light pink color persisted for at least 15 seconds.

The acid number, W_{AV}, was calculated according to the following formula:

$$W_{AV} = \frac{56{,}1 \times c \times V}{m}$$

Wheares:

Acid value (Wav): is the number of milligrams of potassium hydroxide (KOH) used to neutralize free fatty acids present in 1 g of fat;

Coefficient 56.1: is the molecular weight of KOH;

c: is the concentration of the standard potassium hydroxide solution used, in moles per liter (mol/L);

V: is the volume of the potassium hydroxide standard solution used, in mL;

m: is the mass of the test portion, in grams (g).

Peroxide value: Determination of peroxide value - Method to determine the end point of Iodine titration (observation with the naked eye) according to TCVN 6121:2018 and ISO 3960:2017 [5]. Firstly,10 g of the test sample was dissolved in 50 mL of the glacial acetic acid/isooctane solution by gently swirling the flask. After 0.5 mL of saturated potassium iodide solution was added, the sample was shaken for 60 seconds, and added 100 mL of distilled water was. In the next stage, 0.01 N sodium thiosulfate standard solution was titrated from yellow-orange to pale yellow, and then added 0.5 mL of starch solution, the solution was turned blue-violet. We continued titration until the solution turned colorless within 30 seconds. Record the number of mL of 0.01 N sodium thiosulfate after titration (V).

Simultaneously, a blank analysis was performed following the same steps as above, recording the number of mL of 0.01 N sodium thiosulfate after titration (V0).

Calculation of the peroxide value (PV), expressed in milliequivalents (meq) of active oxygen per kilogram, was used the following formula:

$$PV = \frac{(V - V_0)\ x\ C_{thio}\ x\ F\ x\ 1000}{m}$$

Wheares:

V is the volume, in milliliters, of the sodium thiosulfate standard solution used for the determination;

V_0 is the volume, in milliliters, of the sodium thiosulfate standard solution used in the blank test;

C_{thio} is the concentration of sodium thiosulfate solution, in moles per liter (mol/L);

m is the mass of the test portion, in grams (g);

F is the coefficient of 0.01 N sodium thiosulfate solution (titration), F = 1.01.

Malondialdehyde (MDA) content: Determination of MDA content - TBARS method (Papastergiadis et al., 2022) [6]. The pureed sample weighed about 4 - 5 g of in a 200 mL beaker, then added 15 mL of 7.5% Trichloroacetic acid extract solution, was stirred the mixture, and extracted for 15 minutes, then filtered through filter paper. Once this stage is completed, 2.5 mL of the filtrate was drawn into a 10 mL test tube, then added 2.5 mL of the thiobarbituric acid solution, before being capped in the tube. After heating the test tube in boiling water for about 40 minutes, the test tube was cooled under running water to room temperature before determining the optical absorbance at 532 nm.

Malondialdehyde (MDA) content was calculated from the standard curve built with MDA concentration from 0.01 to 0.05 m according to the equation y = 0.1982x + 0.0433 (= 0.9986).

The MDA content on the analyzed samples was calculated according to the following formula:

$$MDA = \frac{\frac{Abs - b}{a} \times V \times 72.06}{1000 \times g}$$

Wheares:

Abs: Measured optical absorbance;

a, b: coefficients of the standard curve equation just built, with b = 0.0433; a = 0.1982;

V: Initial sample volume after homogenization with TCA;

72.06: Molecular Mass of MDA;

g: sample weight.

2.2.3. Data processing methods

Data were collected and processed using Microsoft Excel software to give mean and standard deviation. Using statistical software Statgraphics Centurion 16.1, analysis of variance (ANOVA) and LSD test (least significant difference) to conclude the difference between means of treatments.

3. RESULT AND DISCUSSION

3.1. Total lipid content in fried products (fish balls, beef balls, shrimp balls)

Lipids in food are present in many different forms such as monoglycerides, diglycerides, triglycerides, sterols, free fatty acids, phospholipids, carotenoids, and fat-soluble vitamins. The determination of the total lipid content is a basis for the analysis of the next criteria, the results of determining the total lipid content are shown in Table 1.

***Table 1**: Analysis results of total lipid content (%) in fried products (fish balls, beef balls, shrimp balls)*

Location	***Product type***		
	Fish	***Beef***	***Shrimp***
1	15.37 ± 0.04^{a}	13.39 ± 0.02^{f}	17.88 ± 0.02^{b}
2	18.88 ± 0.03^{d}	12.66 ± 0.05^{c}	21.74 ± 0.07^{g}
3	20.25 ± 0.07^{f}	13.04 ± 0.07^{d}	19.48 ± 0.03^{e}
4	21.77 ± 0.04^{h}	13.19 ± 0.01^{e}	22.03 ± 0.07^{h}
5	21.87 ± 0.04^{h}	14.88 ± 0.02^{h}	23.57 ± 0.04^{i}
6	16.26 ± 0.05^{b}	11.48 ± 0.03^{a}	18.49 ± 0.01^{d}
7	17.75 ± 0.07^{c}	12.03 ± 0.07^{b}	15.87 ± 0.04^{a}
8	19.36 ± 0.05^{e}	14.19 ± 0.01^{g}	18.27 ± 0.04^{c}
9	20.68 ± 0.02^{g}	12.96 ± 0.07^{d}	20.64 ± 0.07^{f}
Average	$\mathbf{19.13 \pm 2.24^{B}}$	$\mathbf{13.09 \pm 1.00^{A}}$	$\mathbf{19.77 \pm 2.35^{C}}$

Note: The letters a, b, c, d, f, g, h in the same column represents the significant difference of the treatments according to the LSD test at the 95% confidence level;

The letters A, B, C in the same row represent the significant difference of the treatments according to the LSD test at the 95% confidence level.

Table 1 shows that the total lipid content in fried products has a statistically significant difference ($P < 0.001$). Shrimp pellets have the highest total lipid content compared to fish balls and beef balls, the reason is that in the raw materials of beef and fish, there is already a high-fat content compared to shrimp, so the fat content is added to shrimp pellets also relatively more than the other two materials. Besides, Table 1 also shows that there is a statistically significant difference in the total lipid content between the selling locations ($P < 0.001$). The main reason for the difference in total lipid content is that the source of semi-finished products collected by trading locations in different establishments (producing meat, fish balls, shrimp balls) leads to different compositions ingredients, namely the fat in various fried products.

In addition, the statistical results also show the interaction between fried products and the selling locations ($P < 0.001$). Compared with the cost of fried products that the research team recorded during the sampling process; it shows that places selling products with high total lipid content will have a high price (about 60,000 VND/100g of product after frying) is lower than the places where fried products have low total lipid content (about 70,000 VND / 100g of products after frying). The high-fat content in fried products is a risk that leads to strong oxidation, affecting the quality of the product and the health of the consumer.

3.2. Acid value in frying oil

Samples of frying oil were collected at the end of the day at retail locations in Ninh Kieu district - Can Tho city. The color of the frying oil at the retail locations is shown in Figure 1.

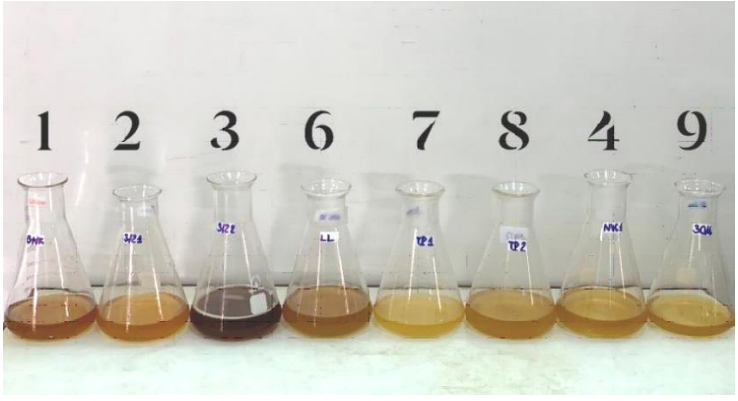

***Figure 1**. Oil samples were collected at the selling locations*

Observing the color of the oil shown in Figure 1 shows that the oil sample collected at selling location number 3 has the darkest color and the highest viscosity due to repeated frying. The oil samples' acid values were analyzed to find out more precisely. The results of the acid number determination of the oil samples are shown in Table 2.

Table 2. *Results of analysis of acid value in frying oil*

Location	*Acid number W_{av} (mg KOH)*
1	0.60 ± 0.02^{a}
2	1.00 ± 0.02^{c}
3	1.00 ± 0.02^{c}
4	0.80 ± 0.02^{b}
6	0.60 ± 0.02^{a}
7	0.60 ± 0.02^{a}
8	0.60 ± 0.02^{a}
9	0.60 ± 0.02^{a}

Note: The letters a, b, c in the same column represents the significant difference of the treatments according to the LSD test at the 95% confidence level.

From Table 2, it is shown that the acid value in the frying oil samples at the sale locations ranges from 0.6 - 1 mg KOH and shows the difference with statistical significance ($P < 0.001$). The reason is that the quality of oil in business establishments has differences in the origin of the type of oil used and the number of times to reuse the frying oil. The results from Table 2 show that: the group of locations with high acid values in frying oil are: 3, 2, 4, 1.2 - 1.4 times higher than that specified in TCVN 7597-2018 [7] on acid value for refined oil products. The results of the analysis are completely consistent with the judgment from Figure 1 about the color of the frying oil at the places of sale.

3.3. Peroxyde value in frying oil

Peroxide is a primary product of fat oxidation, so this compound is quickly converted to secondary products such as aldehydes, ketones, alcohols, and short-chain hydrogen. Therefore, in fried products, the total fat content is in the range of 11 - 22%. Therefore, the presence of residual peroxide compounds is very low, and not identifiable. However, in the frying oil, the residual peroxide content is quite high, the results of the analysis of the peroxide value in the frying oil at the selling locations are presented in Table 3.

Table 3*. Results of analysis of peroxide value in frying oil*

Location	**Peroxyde number(meq/kg)**
1	4.59 ± 0.01^{e}
2	3.59 ± 0.01^{c}
3	2.83 ± 0.01^{b}
4	4.07 ± 0.01^{d}
6	2.57 ± 0.01^{a}
7	5.78 ± 0.01^{g}
8	4.92 ± 0.01^{f}
9	2.83 ± 0.01^{b}

Note: The letters a, b, c, d, e, f, g in the same column represent the significant differences of the treatments according to the LSD test at the 95% confidence level.

The peroxide value characterizes the degree of oxidation of the frying oil. Table 3 shows that the peroxide values in the collected frying oil samples ranged from 2.57 to 5.78 (meq/kg). Compared with the provisions of TCVN 7597-2018 [7] on the peroxide value for refined oil products, the frying oil samples at the selling locations are still within the allowable threshold. However, there is a statistically significant difference in the peroxide value in frying oil at different locations ($P < 0.001$). The reasons for these differences are due to the different oil quality at different business locations and the different number of times the oil is reused.

The current status of using reusable grease in food processing facilities has also been detected and warned by many authorities. Specifically, Vinh Long Food Safety and Hygiene Department (2013) has carried out monitoring and sampling of food contamination hazards at production, processing, and catering establishments, and street food businesses in Vinh Long City in the last 6 months of 2013 [8]. The results showed that 35/42 samples of frying oil did not meet the peroxide value in frying fat. Similar to the report of the Can Tho Branch of Food Safety and Hygiene [8], the results of testing oil samples being fried in districts in November and December 2016 showed that all food service establishments have reused grease many times. Most of the samples of grease that are being fried have the lowest permissible limit of 1.27 times and the highest of 11.2 times (the limit of detecting rancid grease of the Kit OT04 with the peroxide value above 2.75 meq/kg). These results show that people who directly process food at establishments of production and processing, food service business, and street food business may be for-profit purposes and lack understanding about the danger of reusing grease many times. Therefore, the authorities need to actively propagate and mobilize the people, as well as strengthen inspection and supervision activities on food safety.

3.4. MDA content in fried products (fish balls, beef balls, shrimp balls) and frying oil

3.4.1. MDA content in fried products

MDA (Malonaldehyde) is a by-product of the oxidation of unsaturated fatty acids containing 2 or more double bonds. The method of determining MDA content is very commonly used to assess oxidation in foods. The higher the MDA content in a food, the more oxidized the fat in the food is, affecting the quality of the product during processing, and at the same time MDA also carries toxins that affect human health consumption.

Table 4 shows that the difference in the MDA index between fried products is statistically significant ($P < 0.01$). Specifically, the MDA content results for fish ball products were the highest, followed by shrimp and beef. This difference is due to the lipid content and type of fat in different fried products. Specifically, in meat ball product, the fat content is mainly from bovine and pig fat, which are saturated fats, so fat oxidation takes place at a lower rate. For shrimp balls, the main ingredients are starch and lard, so the level of fat oxidation in this product is not high. Particularly for fish balls, the ingredients are fish

and pork fat, in the raw fish used, the unsaturated fat content is present in the muscle or the fish fat, this is the ingredient that participates in the process of fat oxidation, resulting in the highest MDA content in this product group.

Table 4. *Results of analysis of MDA content (µmol/L) in fried products (fish balls, beef balls, shrimp balls) at retail locations in Ninh Kieu district - Can Tho city*

Location	***Product Type***		
	Fish	***Beef***	***Shrimp***
1	1.275 ± 0.279^{d}	0.734 ± 0.231^{bc}	1.272 ± 0.099^{d}
2	0.836 ± 0.086^{c}	1.129 ± 0.398^{d}	0.932 ± 0.116^{c}
3	1.248 ± 0.307^{d}	0.626 ± 0.147^{abc}	0.495 ± 0.036^{ab}
4	0.610 ± 0.054^{ab}	0.415 ± 0.063^{a}	0.403 ± 0.051^{a}
5	0.500 ± 0.065^{a}	0.487 ± 0.043^{a}	0.377 ± 0.060^{a}
6	0.858 ± 0.088^{c}	0.738 ± 0.060^{bc}	0.973 ± 0.086^{c}
7	0.707 ± 0.235^{abc}	0.622 ± 0.069^{abc}	0.989 ± 0.273^{c}
8	0.744 ± 0.034^{bc}	0.820 ± 0.207^{c}	0.555 ± 0.046^{b}
9	0.562 ± 0.079^{ab}	0.523 ± 0.090^{ab}	0.426 ± 0.029^{ab}
Average	**0.815 ± 0.307^{B}**	**0.677 ± 0.262^{A}**	**0.714 ± 0.330^{A}**

Note:
- The letters a, b, c, d in the same column represent the significant difference of the treatments according to the LSD test at the 95% confidence level;
- The letters A and B in the same column represent the significant difference of the treatments according to the LSD test at the 95% confidence level.

Besides, Table 4 also shows that there is a statistically significant difference in MDA content between the selling locations ($P < 0.001$). The difference in MDA content between locations indicates that the sources of raw materials for fish balls, beef balls, and shrimp balls of different locations are imported from different production facilities, the main ingredients that make up these products are also different, leading to significant fluctuations in price and quality. The study results are presented in Table 5, showing that the MDA index of fried products collected on 5 consecutive days did not have a statistically significant difference. However, according to the data obtained during 5 consecutive days of sampling, the highest MDA concentration in fried products can be observed in the last days of the cycle (day 4). It shows that, at retail locations, sellers tend to change the oil every 3 - 4 days.

Table 5. *MDA content (µmol/L) in fried products (fish balls, beef balls, shrimp balls) at retail locations in Ninh Kieu district - Can Tho city, during 5 days of survey*

Location	Date	Product type		
		Fish	Beef	Shrimp
1	1	1.17 ± 0.007^{b}	1.13 ± 0.007^{e}	1.33 ± 0.009^{d}
	2	0.84 ± 0.005^{a}	0.70 ± 0.003^{d}	1.27 ± 0.004^{b}
	3	1.39 ± 0.005^{c}	0.64 ± 0.001^{c}	1.10 ± 0.005^{a}
	4	1.42 ± 0.003^{d}	0.57 ± 0.005^{a}	1.34 ± 0.008^{e}
	5	1.55 ± 0.005^{e}	0.61 ± 0.004^{b}	1.30 ± 0.002^{c}
2	1	0.68 ± 0.003^{a}	0.77 ± 0.008^{a}	0.83 ± 0.004^{a}
	2	0.85 ± 0.007^{b}	0.91 ± 0.005^{c}	0.86 ± 0.002^{b}
	3	0.86 ± 0.002^{b}	1.63 ± 0.006^{e}	1.12 ± 0.007^{e}
	4	0.91 ± 0.001^{c}	1.48 ± 0.007^{d}	0.90 ± 0.002^{c}
	5	0.85 ± 0.007^{b}	0.85 ± 0.001^{b}	0.95 ± 0.004^{d}
3	1	1.08 ± 0.008^{b}	0.48 ± 0.006^{a}	0.47 ± 0.006^{a}
	2	1.14 ± 0.001^{c}	0.48 ± 0.007^{a}	0.56 ± 0.002^{c}
	3	1.03 ± 0.002^{a}	0.65 ± 0.005^{b}	0.47 ± 0.007^{a}
	4	1.78 ± 0.008^{e}	0.82 ± 0.008^{d}	0.49 ± 0.003^{b}
	5	1.20 ± 0.001^{d}	0.69 ± 0.002^{c}	0.47 ± 0.007^{a}
4	1	0.58 ± 0.002^{a}	0.39 ± 0.008^{c}	0.39 ± 0.009^{c}
	2	0.58 ± 0.002^{ab}	0.37 ± 0.007^{b}	0.45 ± 0.003^{d}
	3	0.59 ± 0.003^{b}	0.42 ± 0.008^{d}	0.45 ± 0.002^{d}
	4	0.58 ± 0.007^{ab}	0.52 ± 0.002^{e}	0.33 ± 0.003^{a}
	5	0.70 ± 0.001^{c}	0.36 ± 0.001^{a}	0.38 ± 0.003^{b}
5	1	0.51 ± 0.002^{c}	0.41 ± 0.008^{a}	0.46 ± 0.008^{d}
	2	0.46 ± 0.005^{b}	0.53 ± 0.001^{d}	0.35 ± 0.003^{b}
	3	0.40 ± 0.007^{a}	0.49 ± 0.005^{b}	0.40 ± 0.005^{c}
	4	0.55 ± 0.001^{d}	0.48 ± 0.005^{b}	0.31 ± 0.004^{a}
	5	0.56 ± 0.002^{e}	0.51 ± 0.006^{c}	0.35 ± 0.005^{b}
6	1	0.80 ± 0.002^{b}	0.75 ± 0.002^{c}	0.96 ± 0.002^{b}
	2	0.82 ± 0.003^{c}	0.71 ± 0.004^{b}	0.95 ± 0.002^{b}
	3	0.78 ± 0.007^{a}	0.81 ± 0.006^{d}	0.85 ± 0.002^{a}
	4	0.88 ± 0.006^{d}	0.75 ± 0.005^{c}	1.01 ± 0.002^{c}
	5	1.00 ± 0.006^{e}	0.65 ± 0.004^{a}	1.08 ± 0.007^{d}
7	1	0.65 ± 0.002^{b}	1.06 ± 0.001^{e}	0.60 ± 0.002^{c}
	2	0.66 ± 0.002^{c}	0.70 ± 0.004^{c}	0.53 ± 0.004^{b}
	3	0.45 ± 0.005^{a}	0.67 ± 0.008^{b}	0.49 ± 0.007^{a}
	4	1.09 ± 0.002^{e}	1.03 ± 0.003^{d}	0.60 ± 0.006^{d}
	5	0.67 ± 0.002^{d}	0.63 ± 0.002^{a}	0.54 ± 0.001^{b}
8	1	0.73 ± 0.007^{b}	1.06 ± 0.001^{e}	0.60 ± 0.002^{c}
	2	0.76 ± 0.002^{c}	0.70 ± 0.004^{c}	0.53 ± 0.004^{b}
	3	0.69 ± 0.002^{a}	0.67 ± 0.008^{b}	0.49 ± 0.007^{a}
	4	0.78 ± 0.002^{d}	1.03 ± 0.003^{d}	0.60 ± 0.006^{c}
	5	0.76 ± 0.001^{c}	0.63 ± 0.002^{a}	0.54 ± 0.001^{b}
9	1	0.48 ± 0.002^{a}	0.38 ± 0.003^{a}	0.46 ± 0.005^{e}
	2	0.61 ± 0.005^{d}	0.51 ± 0.001^{b}	0.43 ± 0.001^{c}
	3	0.53 ± 0.005^{c}	0.53 ± 0.005^{c}	0.44 ± 0.004^{d}
	4	0.50 ± 0.002^{b}	0.59 ± 0.008^{d}	0.42 ± 0.001^{b}
	5	0.67 ± 0.008^{e}	0.59 ± 0.002^{d}	0.38 ± 0.002^{a}

Note: The letters a, b, c, d, e in the same column at the survey sites indicate the significant difference of the treatments (sample collection time) according to the LSD test at the level of 95% confidence.

3.4.2. The content of MDA in frying oil

The results in Table 6 show that the analyzed MDA content in the fried oil samples at different selling locations has a statistically significant difference ($P < 0.001$). The group of selling location with high MDA content are 4, 3, 8, and 2, this result is consistent with the results obtained from the acid, peroxide, and color parameters of the frying oil presented in the previous section. These locations use highly oxidized frying oil, resulting in significantly altered frying oil quality. The group of selling locations with low MDA indexes are 9, 1, 6, and 7. The survey was conducted to collect frying oil samples at the locations for sale on a fixed day, so the analysis results showed fluctuations in the amount of oil. Oil quality due to oxidizing agents fluctuates significantly. The reason is that the number of times to reuse the frying oil and the time to change the new frying oil in these locations, is different.

Table 6. *Results of analysis of MDA content in frying oil at locations in Can Tho city.*

Location	*MDA content (µmol/L)*
1	1.44 ± 0.12^{bc}
2	1.90 ± 0.28^{cd}
3	2.60 ± 0.04^{ef}
4	2.98 ± 0.36^{f}
6	0.90 ± 0.08^{b}
7	0.22 ± 0.24^{a}
8	2.35 ± 0.40^{de}
9	1.47 ± 0.08^{c}

Note: The letters a, b, c, d, e, f in the same column indicates the significant difference of the treatments according to the LSD test at the 95% confidence level.

4. CONCLUSION

Through the process of surveying the quality of fried products (fish balls, beef balls, shrimp balls) sold in Ninh Kieu district - Can Tho city, specifically 9 survey locations during 5 consecutive days. The analysis showed that fat content and fat oxidation level in fish balls and shrimp balls were higher than in beef balls. Moreover, the fat content and degree of fat oxidation at the sampling sites differed when considering within the same product category. Compared to the cost of the products, the research team found that places selling products with high-fat content will cost about 7-10% lower than other locations. The highest MDA content in fried products was obtained in the last days of the cycle (day 4). This was further clarified when the survey was conducted to collect frying oil at the retail locations randomly at the end of the day, the analysis results showed that the fluctuation in oil quality due to oxidizing agents has a significant effect on the oil quality. fluctuate significantly. There are differences in the quality of oil in business establishments in terms of the origin of the type of oil used, the number of times the reuse of frying oil, and the new frying oil change cycle in these locations. In selling location number 2, frying products and frying oil both had

significantly higher oxidation-related indicators than in the other locations. The initial research results have partly reflected the current status of food safety and hygiene and potential risks in the fried meatballs and fish balls group. To help consumers, especially young people, they will be interested in and protect their health when using these products.

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Đánh giá an toàn thực phẩm của thịt viên và cá viên chiên ở địa bàn quận Ninh Kiều, thành phố Cần Thơ

Huỳnh Thị Phương Loan, Đỗ Thị Anh Thư, Nguyễn Thị Thanh Tuyền, Lê Nguyễn Bảo Ngọc, Nguyễn Quế Trân

Viện Công nghệ sinh học và Thực phẩm, Trường Đại học Cần Thơ, Thành phố Cần Thơ, Việt Nam

Tóm tắt

Nghiên cứu được thực hiện nhằm đánh giá mức độ oxy hóa của chất béo và hiện trạng tái sử dụng dầu mỡ dùng để chiên rán các sản phẩm cá viên, bò viên, tôm viên tại 9 địa điểm trong 5 ngày liên tiếp, đây là các điểm tập trung bày bán chủ yếu 3 sản phẩm này ở quận Ninh Kiều, thành phố Cần Thơ. Kết quả nghiên cứu cho thấy hàm lượng chất béo trong các sản phẩm này có sự khác biệt rõ rệt, cụ thể: cá viên (15 - 21%), bò viên (11 - 14%), tôm viên (15 - 23%). Vì 03 loại sản phẩm chiên này có nguồn gốc của loại chất béo khác nhau nên dẫn đến mức độ oxy hóa của các sản phẩm này cũng khác biệt thể hiện ở các thông số liên quan đến sự biến đổi của chất béo như: trị số acid, trị số peroxyde và hàm lượng malondialdehyde (MDA). Cụ thể hàm lượng MDA cao nhất ở cá viên, thấp nhất ở bò viên, bên cạnh đó kết quả phân tích cho thấy hàm lượng MDA cao nhất trong sản phẩm chiên được thu nhận ở những ngày cuối của chu kỳ (ngày thứ 4). Trị số acid trong các mẫu dầu chiên có giá trị từ 0 - 1 mg, trị số peroxyde từ 2 - 5,78 meq, hàm lượng MDA dao động từ 0,22 - 2,98 µmol/L. Kết quả cho thấy tại các địa điểm bày bán, người bán tái sử dụng lại dầu chiên và có xu hướng thay dầu sau khoảng 3 - 4 ngày/lần.

Từ khóa: *Thịt cá viên chiên, oxy hóa chất béo, dầu chiên rán, an toàn thực phẩm.*