OXIDATION STABILITY OF RAW PORK PATTIES AS AFFECTED BY REPLACING PORK FAT WITH DIFFERENT PRE-EMULSIFIED HEALTHY OILS

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Abstract – The increasing interest in health has heightened the need for enhancing the functional value of food. Many recent studies have focused on improving healthier lipid profile of meat products. The treatments of the experimental design of replacing pork fat with different pre-emulsified oils were: C (with pork back fat), OOE (with olive oil emulsion), HOE (with hazelnut oil emulsion) and FOE (with flaxseed oil emulsion). The raw pork patties were stored at 7±2 °C for 13 days. The pH, color parameters, 2-thiobarbituric acid reactive substances (TBARS) value and carbonyls content were measured. The results were as follows: pH values of OOE, HOE and FOE were higher (P < 0.05) than C. During refrigerated storage, a* value of C and FOE were significantly decreased (P < 0.05); TBARS values and carbonyls contents of C and FOE were increased (P < 0.05). The results suggested that olive oil were the best oil suited for patties.

Key Words –antioxidant, functional meat products, emulsified oil

I. INTRODUCTION

Nowadays, consumer interested in improving health through diet. Therefore, developing healthier lipid profile of meat products by replacing saturated fatty acids (SFAs) with monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) is necessary [1]. In order to achieve the nutritional and functional benefits, various meat products have been made using vegetable oils such as olive oil (at least 70% of MUFAs), hazelnut oil (at least 80% of MUFAs) and flaxseed oil (at least 50% of n-3 PUFAs).

Technology of incorporating oil by pre-emulsified form in meat products is generally used. Pre-emulsions have a fine consistency and good binding ability. The oils which are stabilized in protein matrix can remain stable and inhibit lipid oxidation during processing and storage [2]. The oxidation stability of raw pork patties as affected by replacing pork fat with different pre-emulsified healthy oils were studied.

II. MATERIALS AND METHODS

Preparation of pre-emulsified oils

Pre-emulsified olive, hazelnut and flaxseed oil were prepared by homogenizing eight parts of water (at room temperature) with one part of ISP for 2 min and adding 10 parts of the oil for another 2 min. The oil emulsions were stored at 4 °C within 24 h.

Preparation of pork patties

Table 1 were shown four different pork patties which fat content to be 20% (according to the protein, fat and moisture content of raw material); which procedures were made as follows: Raw ground meat was mixed with salt for 2 min. Fat or pre-emulsified oils were added for another 2 min. Each patty weighed 60g, wrapped with plastic film and stored at 7±2 ℃. Analysis were carried out at 1, 5, 9 and 13 days.

Table 1. Formulation (g) of pork patties

Ingredients	C	Pre-emulsion treatments		
		OOE	HOE	FOE
Pork Meat	685	655	655	655
Pork Backfat	200			
Water	115			
Olive oil emulsion		345		
Hazelnut oil emulsion			345	
Flaxseed oil emulsion				345
NaCl	20	20	20	20

pH values

The pH values were determined with a pH meter (MP220, Mettler Toedo, Sweden) after blending 10 g of sample with 90 mL of distilled water for 2 min in a homogenizer (PH91, SMT, USA).

Color changes in pork patties

Color changes were monitored with a colorimeter (SP 60 Portable Sphere Spectrophotometer, X-Rite, Grandville, Michigan). Color was expressed with L* (100 = white, 0 = black), a* (positive = redness, negative = greenness), and b* (positive = yellowness, negative = blueness) values, CIELAB color parameters. Color readings were measured on three randomly chosen spots on the patties.

Determination of TBARS values

TBARS were quantified using the method described by Faustman et al. [3]. 10 g sample was homogenized with 25 mL 20% trichloroacetic acid and 20 mL distill water for 2 min at 10000 rpm. The blended sample was filtered through filter paper (Advantec no. 1). 2 mL filtrate and 2 mL 0.02M thiobarbituric acid (TBA) were mixed and incubated in a water bath at 100 ˚C for 30 min. The absorbance at 532 nm was measured after the solution had been cooled with cold water for 10 min.

Determination of total protein carbonyls

Protein oxidation was measured according to the method outlined by Vuorela et al. [4]. 1 g Samples were homogenized with 10 mL of 0.15 M KCl for 60 s. 100 µl of homogenate was transferred into a 2 mL tube, where 1 mL of 10% trichloroacetic acid was added. The sample was centrifuged for 5 min at 5000 rpm, and the supernatant was removed, 1 mL of 2 M HCl with 0.2% 2,4-dinitrophenyl hydrazine (DNPH) was added. After an incubation of 1 h (shaken every 20 min), 1 mL of 10% trichloroacetic acid was added. The sample was vortexed and centrifuged for 5 min at 5000 rpm. Supernatant was removed carefully without damaging the pellet with pipet. The pellet was washed with 1 mL of ethanol/ethyl acetate (1:1), shaken, and centrifuged for 5 min at 10000 rpm; this procedure was repeated two to three times. After, the pellet was completely dried with nitrogen. The pellet was dissolved in 1.5 mL of 20 mM sodium phosphate buffer with 6 M guanidine hydrochloride, shaken, and centrifuged for 2 min at 5000 rpm. Carbonyls were measured spectrophotometrically at 370 nm.

Statistical analysis

All the statistical analyzes were carried out by SAS University Edition.

III. RESULTS AND DISCUSSION

pH values of pork patties during refrigerated storage

The pH values of pork patties were presented in Table 2. The pH values of OOE, HOE and FOE were higher ($P < 0.05$) than C. These results could be attributed to the high pH value of olive oil emulsion (6.83), hazelnut oil emulsion (6.91) and flaxseed oil emulsion (6.86).

The increase in the pH values of control patties during the refrigerated storage might be due to the proteins degradation and the formation of basic nitrogen compounds [5]. However, the pH values of other treatments were decreased during storage. The higher pH is similarly favorable for bacteria growth, especially Lactobacillus. Organic acids produced by lactobacilli made the pH decrease during storage.

Previous research suggested that relatively small increases in pH may be help for increasing the storage stability of comminuted and restructured meat products [6].

Table 2. The pH of pork patties during refrigerated storage.

Trt	Storage (days)			
	1	5	9	13
C	6.09±0.01 ^{Cc}	6.11±0.02 ^{Cc}	6.13±0.01 ^{Cb}	6.16±0.01 ^{Ca}
OOE	6.38±0.01^{Bab}	6.39±0.01 ^{Ba}	6.36±0.01 ^{Bb}	6.34±0.02 ^{Bb}
HOE	6.44±0.01^{Aab}	6.44±0.01 ^{Aa}	6.41±0.02 ^{Abc}	6.38±0.01 ^{Ac}
FOE	6.44±0.01^{Aa}	6.45±0.01 ^{Aa}	6.43±0.01 ^{Aa}	6.38±0.01 ^{Ab}

$^{A–D}$ Means within columns with different superscript letters are significantly different ($p < 0.05$).
$^{a–d}$ Means within rows with different superscript letters are significantly different ($p < 0.05$).

Color stability of pork patties during refrigerated storage

The changes of a* value were presented in Fig. 1. The decrease of a* value (redness) is related to the oxidation of meat products. a* values of C was higher ($P < 0.05$) than the others and rapidly decreased during storage.
Myoglobin is the heme protein responsible for meat color. When the central iron atom within the heme was oxidized and change from red oxy-myoglobin to brownish Met-myoglobin that decrease a* value. Faustman et al. [7] reviewed that lipid oxidation enhance myoglobin oxidation by reactivity of primary and secondary product derived from unsaturated fatty acids which explained the reason of intensely decreasing in control while 13 days storage.

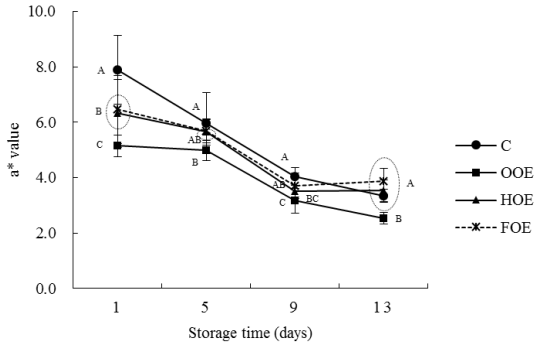

Fig. 1 a* value of pork patties during refrigerated storage.
A–D Within a column, different superscripts indicate significant differences ($P < 0.05$).

Lipid oxidation of pork patties during refrigerated storage

TBARS values were presented in Fig. 2. TBARS values of each treatments over the storage period were in the order: C > FOE > HOE = OOE ($P < 0.05$). TBARS values of C and FOE were rapidly increased during 13 days ($P < 0.05$).
Therefore, pre-emulsified technology could reduce lipid oxidation in the manufacturing of raw pork patties. These inhibiting effects might be due to the structure of oil-in-water which could prevent iron-catalyzed oxidation [8] that consequently inhibit the lipid oxidation of OOE, HOE and FOE which having high unsaturated fatty acids. HOE and OOE enriched in MUFAs instead of PUFAs made them more stable than FOE.

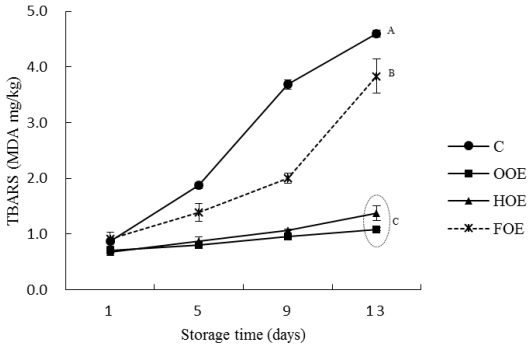

Fig. 2 TBARS (MDA mg/kg) of pork patties during refrigerated storage.
A–D Within a column, different superscripts indicate significant differences ($P < 0.05$).

Protein oxidation during refrigerated storage of pork patties

Carbonyls content of raw pork patties were presented in Fig. 3. Carbonyls content of OOE were lower ($P < 0.05$) than the others. All the samples decreased at 9th day and then intently increased at last storage day. The decreasing of carbonyls content could be due to the formation of cross-link products like Schiff base which were derived from previous carbonyls compounds. In the last storage period, amino acids (cysteines and methionine) which had 'sacrificial protection' in the beginning were oxidized and lead to the increased of carbonyls content [9].

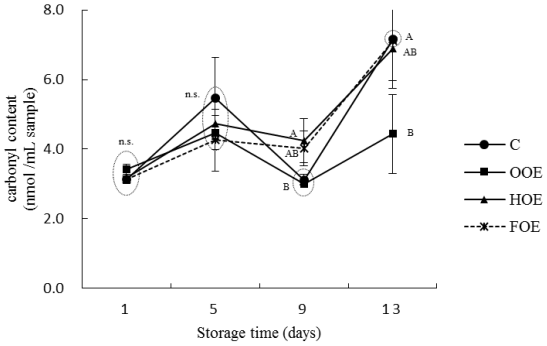

Fig. 3 Carbonyls content (nmol /mL sample) of pork patties during refrigerated storage.
A–D Within a column, different superscripts indicate significant differences ($P < 0.05$).

IV. CONCLUSION

Using pre-emulsified technology for oil enriched with unsaturated fatty acids could stabilize the lipid oxidation. When applied to raw pork patties, there were no negative impact on protein oxidation. Further studies will be necessary to study the effect of heat on the emulsion treatments.

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