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Oxidative Stability of Smoked Chicken Sausage Substituted with Red Palm mid Fraction During Chilled Storage

[1]A.R. Alina, [1]A. Siti Mashitoh, [3]A.S. Babji, [4]I. Maznah, [1]K.M.W. Syamsul and [1]Y. Muhyiddin

[1]Institute for Halal Research and Management, Universiti Sains Islam Malaysia,
71800 Bandar Baru Nilai, Negeri Sembilan, Malaysia
[2]Faculty of Science and Technology, Universiti Sains Islam Malaysia,
71800 Bandar Baru Nilai, Negeri Sembilan, Malaysia
[3]School of Chemical Science and Food Technology,
Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
[4]Institute of Bioscience, Universiti Putra Malaysia, 43400, Serdang, Selangor, Malaysia

Abstract: The effects of rice bran and carboxymethyl cellulose (CMC) on the oxidative stability of smoked chicken sausages were determined. Lipid oxidation was analyzed at several different days of chilled storage (n=3, for all measurements). Thiobarbituric acid (TBA) values and peroxide value (PV) of smoked chicken sausages increased throughout the nine days of storage (4°C). Chicken sausage formulated with Red Palm Mid Fraction (RPMF) showed significantly lower TBA value compared to the samples prepared with chicken fat ($p<0.05$). However, β-carotene content showed the highest significant value ($p<0.05$) in sausage incorporated with RPMF. It was concluded that the utilization of RPMF significantly reduced the oxidation of lipid, which was indicated, by the TBA values. This study also showed that the small amount of dietary fiber (rice bran) also improve the oxidative stability of smoked chicken sausages. It can be suggest that the time for oxidation study need longer storage duration to see the good result plot and changes that occur can be determined clearly.

Key words: Oxidative Stability · Red Palm Mid Fraction · Chicken Fat · Chicken Sausage

INTRODUCTION

Muscle foods contain unsaturated lipid and pro-oxidant components, are prone to lipid oxidation. For the muscle lipid fractions, the polar phospholipids contain the highest proportion of unsaturated fatty acid and it has been established that this fraction, as opposed to the neutral lipid fraction is primarily responsible for lipid oxidation in muscle foods [1]. Rhee [2] reported that even low fat muscle foods are susceptible to lipid oxidation because fat reduction principally reflects a reduction in triglycerides while the phospholipid fraction is much less affected.

Palm oil offers yet another versatile alternative for animal fat replacement in meat products. Various palm oil products can be obtained by means of fractionation, hydrogenation, interesterification, or blending procedures. Palm fats substitutes in meat products could be tailored to suit the functional and economical demands of the users. The high nutritional value of PMF in term of tocopherol and tocotrienols has been added to the coca butter equivalent products [3]. In addition, Ong and Goh [4] and Nesaretnam *et al*. [5] declared that the minor carotenoid [6] constituents in palm oil, namely: carotenes (pro-vitamin A), tocopherols and tocotrienols (provitamin E) have other beneficial health properties including as antioxidant, anti-cancer and cholesterol lowering effect. Palm Mid fraction is another palm fat ingredient which can be used as a fat substitute in food.

In the other side, Babji *et al*. [7], Hsu and Yu [8, 9] have reported that there were no significant differences in the cooking loss, texture, juiciness, aroma, oiliness and overall acceptance between the burgers prepared with palm fats and the conventional ones with beef fat. In another study, Shiota *et al*. [10] have found that aroma for beef patties containing palm oil and palm mid-fraction showed relatively high and constant scores at lipid levels

Corresponding Author: A.R. Alina, Institute for Halal Research and Management, Universiti Sains Islam Malaysia, 71800 Bandar Baru Nilai, Malaysia. Tel: +6019-2623670, E-mail: alina@usim.edu.my.

from 5 to 40 % (w/w). They also observed that beef patties containing Bungo beef (Japanese black cattle) were given the highest scores at the 20 % level of palm oil and palm mid-fraction. Chicken fat is high in unsaturated fats making it easier to be oxidized. The objective of this study is to determine the oxidative stability of chicken burger incorporated with RPMF.

MATERIALS AND METHODS

Sample Preparation: The formulation used in this study is based on the Smoked Tandoori Sausage recipe, which is commercialized by the brand name 'Omar Deli'. The sausage formulations were developed in OmCorp Sdn. Bhd., Kajang, Selangor. Four chicken sausage formulations were compared, each containing 5 % fats.

Two formulations (T1:CF+RB and T2:CF+CL) contained chicken skin as fat and the other two formulations (T3:RPMF+RB and T4:RPMF+CL) were incorporated with RPMF. T1 and T3 were added with 1.5 % of rice bran while T2 and T4 were added with cellulose in same amount. Blends of RPMF were provided by the Carotino Sdn. Bhd. (Pasir Gudang, Johor). Defatted rice bran was supplied from Bernas Sri Tiram Jaya (Tanjung Karang, Selangor). Chicken breast trimming, chicken skin and other dry materials were provided by OmCorp Sdn. Bhd.

Fat Extraction: The oil of the samples was extracted by using cold extraction. The extracted oil then was analyzed to determine the quality of the oil or to carry out the carotene and other fat analysis. The extraction used n-hexane for the extraction reagent to trap the oil. The ratio of the quantity of sausage sample to n-hexane used was 1:3 respectively. In this extraction, 30 g of samples were grounded and homogenized with the 90 ml n-hexane, which were kept overnight. The wide-necked glass bottles or flasks used were wrapped by aluminum foil to avoid the samples from being exposed to the light.

Then the mixture of sample and n-hexane were filtrated using filter paper (Whatman No.1) to remove the solid part, which was the grounded sausage. After that, filtrate was moved into flask and attach to rotary evaporator. The mixture of lipid and n-hexane was transferred into a flask. Discharging the n-hexane solution process was done by using 'Rotavapor-RE' at 400°C until the mixture of n-hexane was totally remove after 25-30 minutes. The extracted oil or fat was put in bottles wrapped in aluminium foil to avoid exposure to the light before being used in the next analysis.

Quality Parameters: Quality was measured by chemical parameters as indicator of oxidative stability through peroxide values and thiobarbituric acid values. Consumer acceptance of the quality of products was also done through sensory tests.

Determination of Peroxide Value: The peroxide value was determined according to the PORIM test method (1995), where the freed iodine was titrated against a solution of sodium thiosulphate. Peroxide value (PV) expressed in miliequivalents of active oxygen per kilogram of sample.

Thiobarbituric Acid Value Determination: TBA value was assessed by using the method of Buege and Aust (1978). A 0.5 g sample of sausage was homogenated and mixed with 2.5 ml of 0.375 % TBA solution, 15 % TCA and 0.25 N of hydrochloric acid (HCl). The mixture was heated for 10 minutes at boiling temperature (100°C) to allow the formation of pink colour. Then, the solution was cooled and centrifuged at 5500-rpm speed for 25 minutes. The absorption of supernatant was determined by using a spectrophotometer (Varian Cary 50) at wavelength of 532 nm. The TBA value calculated based on the following formula:

$$\text{TBA Value} = \text{Reading at 532 nm} \times 2.77$$

Determination of Carotene Content: Carotene was determined by using a UV-Vis Spectrophotometer (Varian Cary 50). The principle applied in this measurement is spectrophotometric measurement at 446 nm of the absorbance of a homogenized and diluted sample. Carotene content was determined in triplicates. The samples were melted at 60°C-70°C and homogenized before taking a test portion. The samples were filtrated through a fast filter paper (Whitman No. 1) if the sample contains impurities or were not clear. 0.1 g of the fat that was extracted from the sausage samples were weighted to the nearest 0.0001 g into the 25 ml volumetric flask. The test portion with a few milliliters of solvent was dissolved and diluted to the mark. Then, the solution transferred to a 1 cm cuvette and measurement was carried out at the ab sorbance of 446 nm against the solvent used. The cuvette error was corrected at the same wavelength. The carotene content is expressed as ppm β-carotene and is given by:

$$25 \times \frac{308}{100(W)} \times (a_s - a_b)$$

Where,

a_s is absorbance of the sample
a_b is the cuvette error
W is the weight of sample in g

Statistical Analysis: Data were evaluated by one-way analysis of variance (ANOVA). The statistical analysis significance of each factor considered was calculated at α= 0.05 level using the F-test. Duncan's multiple range test were carried out to resolve the difference among the treatment means. A value of P<0.05 was used to indicate significance difference. All the statistical evaluation of the results was performed using the Statistical Package for Social Science 12.0 (SPSS).

RESULTS AND DISCUSSION

Peroxide Value: The peroxide values (PV) of the chicken sausage were shown in Table 1, an indicator of primary oxidation, increased in all chicken sausage treatments for the initial storage and generally starts to decrease at the fifth day. PV of the chicken skin was among the highest (p>0.05) throughout the nine days of chilled storage. This correlated with the result reported by Rossell [11], where fewer amounts of natural antioxidant and higher degree of unsaturation in chicken skin compared to palm fat made it less stable against oxidation.

In this study, incorporation of a small amount of rice bran into the formulation for T2 and T4 was adequate in delaying oxidation and improving the quality of products. This was shown, by the significantly lower values (p<0.05) of PV between treatments for overall observation on the result. Mansour and Khalil [12] reported that several fibers have been used in meat products not only to determine their possible beneficial effect on health but also as potential fat substitutes.

Thiobarbituric Acid Value: Thiobarbituric acid (TBA) value measures secondary lipid oxidation products, which were also responsible for the rancid taste developed during storage [11]. TBA of the chicken skin (T1) was the highest (p<0.05) during nine days of chilled storage at 4°C. However, according to [12], the TBA value may increase for the initial storage and start to slow down after a few days and this is because of the malonaldehyde (MDA) decomposition and polymerization. The TBA values of chicken sausages during nine days of chilled storage are shown in Table 2, which steadily increased in this study. However, the treatments formulated with RPMF showed significantly lower (p<0.05) in TBA value, thus indicating that the utilization of RPMF was able to slow the secondary lipid oxidation in smoked chicken sausages.

Carotene Content: The β-carotene content (Table 3) was significantly the highest (p<0.05) in chicken sausage sample that were formulated with RPMF with addition of rice bran during the nine days of chilled storage.

Table 1: Scores mean (mean ± SDE) for peroxide value (PV) for chicken sausage samples during nine days chilled storage

	Treatment			
Day	T1	T2	T3	T4
1	1.885±0.085^{c}	2.580±0.300^{b}	2.840±0.140^{b}	4.335±0.275^{a}
3	6.065±0.045^{a}	3.220±0.120^{c}	2.655±0.105^{d}	4.400±0.140^{b}
5	5.835±0.085^{a}	3.570±0.200^{c}	4.750±0.120^{b}	3.520±0.240^{c}
7	7.560±0.120^{a}	6.745±0.205^{b}	7.485±0.085^{a}	8.470±0.040^{c}
9	8.280±0.430^{ab}	7.495±0.145^{bc}	8.470±0.040^{a}	6.625±0.105^{c}

a-c: Different superscript letter indicate the significant different (p < 0.05)

Table 2: Scores Mean (mean ± SDE) for Thiobarbituric Acid (TBA) Value for Chicken Sausage Samples during nine days Chilled Storage

	Treatment			
Day	T1	T2	T3	T4
1	1.078±0.012^{a}	1.076±0.010^{a}	1.026±0.011^{b}	0.992±0.008^{b}
3	1.278±0.002^{a}	1.168±0.008^{b}	1.113±0.002^{c}	1.039±0.002^{d}
5	1.393±0.008^{a}	1.229±0.006^{b}	1.205±0.008^{c}	1.200±0.007^{c}
7	1.371±0.025^{a}	1.300±0.021^{b}	1.219±0.009^{c}	1.207±0.006^{c}
9	1.143±0.008^{a}	1.333±0.006^{b}	1.237±0.008^{c}	1.202±0.007^{d}

a-c: Different superscript letter indicate the significant different (p < 0.05)

Table 3: Scores Mean (mean ± SDE) of β-Carotene Content for Chicken Sausage Samples during nine days Chilled Storage

	Treatment			
Day	T1	T2	T3	T4
1	149.834±7.65^{c}	166.438±7.65^{c}	213.129±0.45^{b}	284.124±5.68^{a}
3	167.679±15.06^{b}	139.841±15.06^{b}	206.156±10.86^{a}	243.423±2.49^{a}
5	116.565±1.38^{b}	128.909±0.39^{b}	218.394±13.35^{a}	236.768±1.30^{a}
7	122.899±2.14^{c}	114.727±0.49^{d}	207.186±0.45^{b}	234.989±1.38^{a}
9	126.969±0.45^{d}	167.197±0.91^{c}	218.946±0.44^{b}	249.079±0.46^{a}

a-c: Different superscript letter indicate the significant different ($p < 0.05$)

Generally, the β-carotene content (ppm) in samples formulated with rice bran addition in both CF and RPMF indicated significantly higher ($p<0.05$) results especially for the 7 and nine days of chilled storage. However, the existence of carotene in CF may come from chicken fat through animal feed. According to Nam *et al*. [13], rice bran is known to contain high levels of natural antioxidants in different quantities and proportions depending on the variety [14]. The addition of rice bran in formulation of smoked chicken sausage significantly ($p>0.05$) improve the β-carotene in this sausage product.

CONCLUSION

In the oxidation analysis, the results indicated that the TBA value and PV increased throughout the nine days of chilled storage at 4°C. The samples formulated with RPMF and rice bran significantly ($p<0.05$) show the lower PV and TBA value. This indicates that the utilization of RPMF and rice bran in thick chicken sausage samples is able to slow the oxidation rate.

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