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COMPARISON OF FRYING EFFECT OF RICE BRAN OIL AND PALM OLEIN

CHEW HUEIH MING

THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE DEGREE OF BACHELOR OF FOOD SCIENCE WITH HONOURS IN FOOD TECHNOLOGY AND BIOPROCESS

SCHOOL OF FOOD SCIENCE AND NUTRITION
UNIVERSITI MALAYSIA SABAH
2010
DECLARATION

I hereby declare that the material in this thesis is my own except for quotations, excerpts, equations, summaries and references, which have been duly acknowledged.

16 APRIL 2010

CHEW HUEIH MING
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### CERTIFICATION

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CHEW HUEIH MING
16 APRIL 2010
Kajian ini dijalankan untuk membandingkan kesan penggorengan minyak dedak dengan minyak kelapa sawit. Kedua-dua jenis minyak digunakan sebagai medium penggorengan untuk menggoreng kentang goreng. Penggorengan ini dijalankan secara berterusan sebanyak enam jam sehari selama lima hari pada suhu 185 ± 5°C. Sampel minyak dikumpulkan pada hari penggorengan yang kelima dan digunakan untuk analisis kimia seperti asid lemak bebas, nilai peroksida, warna, nilai p-anisidin, nilai iodin dan titik asap. Kedua-dua minyak menunjukkan peningkatan dalam asid lemak bebas, nilai peroksida, warna dan nilai p-anisidin manakala terdapat pengurangan dalam nilai iodin dan titik asap sepanjang masa penggorengan. Minyak dedak mengalami peningkatan asid lemak bebas yang lebih kecil berbanding dengan minyak kelapa sawit di mana asid lemak bebas minyak dedak meningkat dari 0.142 ± 0.007% ke 0.66% dan 0.079% ke 0.93 ± 0.01% untuk minyak kelapa sawit. Minyak dedak menunjukkan peningkatan yang konsisten dalam penentuan nilai peroksida iaitu dari 3.9 ± 0.007 meq per kg ke 13.35 ± 0.21 meq per kg manakala minyak kelapa sawit mempunyai nilai awal pada 3.4 meq per kg dan meningkat ke 34.55 ± 1.48 meq per kg pada hari penggorengan yang kelima. Warna minyak dedak menunjukkan peningkatan yang lebih banyak dalam kemerahan dan kekuningan tetapi kurang kehitaman berbanding dengan minyak kelapa sawit. Nilai p-anisidin meningkat sepanjang masa penggorengan bagi kedua-dua minyak di mana peningkatan dari 12.19 ± 0.20 ke 32.65 ± 1.06 untuk minyak dedak. Minyak kelapa sawit mempunyai peningkatan yang lebih banyak berbanding dengan minyak dedak iaitu dari 10.45 ± 0.15 ke 60.75 ± 0.19. Kedua-dua minyak menunjukkan pengurangan dalam nilai iodin di mana nilai iodin minyak dedak menurun dari 94.5 ± 0.75 ke 66.5 ± 1.27 manakala nilai iodin minyak kelapa sawit menurun dari 50.9 ± 2.10 ke 44.6 ± 0.14. Dalam penentuan titik asap pula, titik asap menurun dari 235 ± 1°C ke 187.5 ± 0.7 dan dari 220 ± 1°C ke 177.5 ± 0.7°C untuk minyak dedak dan minyak kelapa sawit masing-masing. Kualiti kentang goreng selepas penggorengan juga ditentukan dengan penilaian sensori. Kentang goreng yang digoreng dengan minyak dedak masih diterima oleh ahli panel walaupun digoreng selama lima hari manakala kentang goreng yang digoreng dengan minyak kelapa sawit pada hari ketiga mempunyai min yang paling tinggi bagi semua ciri-ciri sensori. Kesimpulannya, minyak dedak mempunyai kestabilan yang lebih baik berbanding dengan minyak kelapa sawit dalam penggorengan.
ABSTRACT

COMPARISON OF FRYING EFFECT OF RICE BRAN OIL AND PALM OLEIN

This research was conducted to determine the frying effect of rice bran oil by comparing with palm olein. The oils were used as a frying media to fry French fries continuously for six hours a day up to a maximum of five days at a temperature of 185 ± 5°C. Oil samples were collected on the fifth frying day and analyzed for free fatty acid, peroxide value, colour, p-anisidine value, iodine value and smoke point. At the end of the frying period, free fatty acid, peroxide value, colour and p-anisidine value increased whereas the iodine value and smoke point decreased. The rate of free fatty acid (FFA) formation of rice bran oil was slightly lower than the palm olein during five days frying. FFA of rice bran oil increased from 0.142 ± 0.007% to 0.66% compared to palm olein which was from 0.079% to 0.93 ± 0.01%. Peroxide value of rice bran oil showed consistent increased from 3.9 ± 0.007 meq per kg to 13.35 ± 0.21 meq per kg while palm olein marked the initial value at 3.4 meq per kg and then increased to 34.55 ± 1.48 meq per kg on the fifth day. The colour of rice bran oil showed increased in redness and yellowness but less dark than the palm olein after the frying period. The level of p-anisidine value (p-Av) for rice bran oil increased from 12.19 ± 0.20 to 32.65 ± 1.06 from the initial to the end of frying day. Palm olein had higher rate of changes in p-AV compared to rice bran oil which was from 10.45 ± 0.15 to 60.75 ± 0.19. The rate of changes of iodine value decreased over frying time for both oils. Iodine value (IV) of rice bran oil decreased from 94.5 ± 0.75 to 66.5 ± 1.27 while IV of palm olein decreased from 50.9 ± 2.10 to 44.6 ± 0.14. Smoke point of rice bran oil and palm olein progressively dropped from 235 ± 1°C to 187.5 ± 0.7 and from 220 ± 1°C to 177.5 ± 0.7°C. The quality of the French fries was also determined during the frying period. From the sensory data that obtained, French fries with rice bran oil in the fifth frying day still being accept by the panel compared with French fries with palm olein which had highest mean score in the third frying day in all the sensory aspect. It can be concluded that rice bran oil had better stability than the palm olein during the frying process.
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<td>AOAC</td>
<td>Association of Official Analytical Chemists</td>
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<td>APOC</td>
<td>America Palm Oil Council</td>
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<td>A.V</td>
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<td>MMT</td>
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<td>Na₂S₂O₃</td>
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CHAPTER 1

INTRODUCTION

Deep fat frying is a process which involves immersing a food item in a large quantity of heated oil or fat, which is normally replenished and reused several times before disposed (Aladedunye and Przybylski, 2009). This is one of the methods for food preparation which it can produce desirable flavour and texture. The frying time normally takes 5-10 min and greatly depending on the dimensions of the food being fried and the frying temperature. The frying process normally conducted at temperatures of 175-195°C (Aladedunye and Przybylski, 2009). The food fried at low temperatures results in lighter color, less flavor development and increased oil absorption while foods that fried at high-temperature frying leads to thinner crusts and less oil absorption.

Rice bran oil is gaining production as an additional source of vegetable oil in rice producing countries (Erickson, 1990). Rice bran oil (RBO) is one of the most nutritious and healthful edible oils due to the presence of an abundance of natural bioactive phytoceuticals such as oryzanol, tocopherols, tocotrienols (tocols) and play important roles in preventing some diseases (Rajam et al., 2005). Rice bran oil is more popular to be used as frying oil due to its high smoke point and stability (Gunstone, 2006). Erickson (1990) stated that rice bran oil is an excellent edible oil consumed directly in China, Japan, India and other countries. Rice bran oil has unique frying characteristics which required less oil in frying compared to other oils (Jain, 1987). Refined rice bran oil plays important role as excellent salad and frying oil with high oxidative stability resulting from its high level of tocopherols and tocotrienols (~860ppm) (Gunstone, 2004).

Palm olein is often known as a heavy duty frying oils which normally used in fast food outlets due to its oxidative stability and presence of tocols and
carotenoids composition (Nallusamy, 2006). Unsaturated and saturated fatty acid content of palm olein which consists of 47% saturates, 40% oleic and 11% polyunsaturates contribute good flavor stability (Al-Kahtani, 1991; Rayner et al., 1998). Bracco et al. (1981) reported that palm olein performed satisfactorily and produced fried foods with acceptable cooking qualities compared to soybean, groundnut, sunflower and rapeseed oils and tallow as frying media. Palm olein showed better frying performance than the sunflower oil, soybean oil and corn oil in the determination of effect of frying time on the quality of cooking oil (Ling, 2007). Another study by Hoo (2009) reported that palm olein shown better oxidative stability than the sunflower oil for different frying temperature. The techno-economic advantages of palm olein over other oils and fats make it used as frying oil in food industry (Razali, 2005).

The quality of the frying oil is of great importance with regard to quality of the fried food since the oil used for frying becomes part of the food being fried (Kochhar, 2001). The oil can contribute to the some unique organoleptic and sensory characteristics including flavour, texture and appearance (Aladedunye and Przybylski, 2009). During frying, the oil is subjected to physical and chemical reactions which will affect the oxidative degradation of the oil used in the presence of air and moisture. The chemical reactions including oxidation (presence of air), hydrolysis (caused by the presence of water) and polymerization of unsaturated fatty acid that change the composition of the frying medium (Mariod et al., 2006).

The rate of decomposition of the oil depends on several factors such as temperature and length of frying, type of food fried, composition of the oil, continuous or intermittent frying and fresh oil replenishment. The decomposition of undesirable products also formed due to the interactions between the food ingredients and the oil which will affect the food products’ taste, flavour, colour and shelf life. However, repeating using the frying oils can affect the food quality and promote the formation of compounds that can affect human health (Sanibal and Filho, 2004) and cause the fried foods to have rather limited shelf life due to the development of rancidity in the frying oil taken up by the products (Man and Jaswir, 2000).
After the frying process, the consumers are concerned about the oil quality from the aspects of the colour, smoke point and the degree of rancidity. Some parameters can be used to assess the oil quality such as free fatty acid (FFA), peroxide value (PV), colour of the frying oil, smoke point and fatty acid composition. However, the determination of the oil quality not just depends on the quantitative method as mentioned as above but also depends on quality assessment of the fried products from the sensory aspects (Abdulkarim et al., 2007).

1.1 Objectives

a. To determine and compare the oxidative stability of rice bran oil with palm olein after frying process.

b. To determine the oxidative stability among 0, 1, 2, 3, 4 and 5 frying days of rice bran oil compare with palm olein.

c. To determine the quality of French fries after frying from the aspects of sensory evaluation.
CHAPTER 2

LITERATURE REVIEW

2.1 Rice Bran
2.1.1 Characteristics of Rice Bran

Rice bran is the cuticle between the paddy husk and the rice grain. Rice bran is obtained as a by product of brown rice processing (Amarasinghe et al., 2009) during milling to produce white rice. Rice bran is rich in nutrients with 11-15% proteins, 34-62% carbohydrates, 7-11% crude fibers, 7-10% ashes and 15-20% lipids (Juliano and Hicks, 1996). It is also a good source of minerals such as silica, iron, calcium and zinc (Luh, 1980). Rice bran can be used as a feedstuff for cattle, poultry and swine, and as a source of rice bran oil (Chandler, 1979). McCaskill and Zhang (1999) reported that rice bran has been used as a feedstock and has the potential to be used as a food ingredient and oil source. Rice bran tends to become rancid fairly quickly but it can be stabilized by dry or moist heat treatment (Matz, 1991).

2.2 Rice Bran Oil
2.2.1 Characteristics of Rice Bran Oil

The availability of rice bran oil is low compare to other oils and fats due to inefficient methods of processing of paddy and rice bran in most of the producing countries. Rice bran oil contains higher free fatty acids (FFA) due to lipase action that occurs in rice bran (Erickson, 1990). The high FFA content of rice bran oil was due to the presence of active lipase that destabilized the oil within a short time after milling (Goffman, 2003). About 35 to 70% FFA may be obtained in a month (Pandey, 2008) and the high activity of lipase which caused the hydrolytic rancidity can be avoided either by oil extraction after milling process or stabilization of bran (Ju and Vali, 2005). Rice bran oil is comparable to other vegetable oils for cooking,
salads and shortening if properly processed. Lower quality of rice bran oil is used in soap making and for a few other industrial purposes (Chandler, 1979).

2.2.2 Availability of Rice Bran Oil
Rice bran oil appears to be a potentially sizeable source of edible oil due to the oil content ranges from 12-25% of the rice bran. China is the largest producer of paddy and consequently of rice bran oil. India is the second largest producer follow by Indonesia. The production of rice bran oil has been increasing and may eventually be a comparatively major by-product in every rice producing country. Table 2.1 shows the potential of rice bran oil in major growing countries (in million metric tones).

### Table 2.1: Estimated Potential of Rice Bran Oil in Major Growing Countries (in million metric tones)

<table>
<thead>
<tr>
<th>Country</th>
<th>Rice Bran</th>
<th>Rice Bran Oil Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>9.440</td>
<td>1.426</td>
</tr>
<tr>
<td>India</td>
<td>5.440</td>
<td>0.826</td>
</tr>
<tr>
<td>Indonesia</td>
<td>2.095</td>
<td>0.314</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>1.293</td>
<td>0.194</td>
</tr>
<tr>
<td>Thailand</td>
<td>1.019</td>
<td>0.153</td>
</tr>
<tr>
<td>Burma</td>
<td>0.800</td>
<td>0.120</td>
</tr>
<tr>
<td>Vietnam</td>
<td>0.863</td>
<td>0.130</td>
</tr>
<tr>
<td>Japan</td>
<td>0.776</td>
<td>0.116</td>
</tr>
<tr>
<td>Phillipines</td>
<td>0.499</td>
<td>0.075</td>
</tr>
<tr>
<td>World</td>
<td>2.536</td>
<td>3.804</td>
</tr>
</tbody>
</table>

1 Calculated as 15% yield of oil

2.2.3 Composition of Rice Bran Oil
The major acids that found in rice bran oil are palmitic (12-28%, typically 20%) oleic (35-50%, typically 42%) and linoleic acid (29-45%, typically 32%) (Gunstone, 2004). Rice bran oil has similar fatty acid composition to peanut oil (Anon, 2005) and the saturation level is slightly higher than conventional soybean oil (Nicolosi and Liang, 1991). According to Tahira (2007), lower level of linolenic acid content makes rice bran oil more resistant to oxidation than soybean oil. Sayre (1988) reported that rice bran oil contains 95% saponifiable lipids and 4.2% unsaponifiable
lipids such as tocopherols, tocotrienols, γ-oryzanol, sterols and carotenoids. According to Rajam et al. (2005), crude rice bran oil contains 2-3% wax, 1-2% phosphatides and 5-25% free fatty acid (FFA) content. Table 2.2 shows the fatty acid composition of rice bran oil.

**Table 2.2: Fatty Acid Composition of Rice Bran Oil**

<table>
<thead>
<tr>
<th>Fatty Acid</th>
<th>Chain Length: No of double bonds</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myristic</td>
<td>14:0</td>
<td>0.1-1.0</td>
</tr>
<tr>
<td>Palmitic</td>
<td>16:0</td>
<td>12.0-18.0</td>
</tr>
<tr>
<td>Palmitoleic</td>
<td>16:1</td>
<td>0.2-0.6</td>
</tr>
<tr>
<td>Stearic</td>
<td>18:0</td>
<td>1.0-3.0</td>
</tr>
<tr>
<td>Oleic</td>
<td>18:1</td>
<td>40.0-50.0</td>
</tr>
<tr>
<td>Linoleic</td>
<td>18:2</td>
<td>20.0-42.0</td>
</tr>
<tr>
<td>Linolenic</td>
<td>18:3</td>
<td>0.0-1.0</td>
</tr>
<tr>
<td>Arachidic</td>
<td>20:0</td>
<td>0.0-1.0</td>
</tr>
</tbody>
</table>

Source: Rice Science and Technology (1994)

2.2.4 Physicochemical Properties of Rice Bran Oil

The physicochemical characteristics of rice bran oil for refractive index, peroxide value, iodine value and free fatty acid value are shown in Table 2.3.

**Table 2.3: Physicochemical Characteristics of Rice Bran Oil**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refractive Index</td>
<td>1.4792</td>
</tr>
<tr>
<td>Peroxide Value</td>
<td>0.92 meq/kg</td>
</tr>
<tr>
<td>Iodine Value</td>
<td>105cg/l/g</td>
</tr>
<tr>
<td>Free Fatty Acid</td>
<td>0.07% oleic acid</td>
</tr>
</tbody>
</table>

Source: Anon, 2005a.

2.2.5 Benefits of Rice Bran Oil

Rice bran oil is benefits and promoted for cooking purpose due to its high level of unsaponifiable matters and the presence of the natural antioxidants in the oil such as gamma – oryzanol, tocopherol and tocotrienols. According to Bramley et al. (2000), compounds such as tocotrienols can prevent lipid peroxidation and important in delaying the pathogenesis of degenerative disease such as
cardiovascular disease, cancer, inflammatory diseases, neurological disorders, cataracts, age-related macular degeneration and immunomodulation. Thus, rice bran oil can be termed as nutritional oil and it is important to explore this unique edible oil to its fullest potential for the health benefits (Rajam et al., 2005).

2.2.6 Rice Bran Oil as Frying Oil

Rice bran oil is excellent for frying foods giving low peroxide, foam, free fatty acid and polymer formation (Lynn et al., 1968; Kao et al., 1991). Rice bran oil is more stable under frying conditions compare to other vegetable oils due to more even balance between linoleic and oleic acid, the low level of linolenic acid and presence of powerful antioxidants (Sayre, 1988; Sayre and Saunders, 1990). There are some problems which caused by dark colour, haziness, higher amounts of unsaponifiables and foaming during frying that can affect the edible oil quality (Tahira et al., 2007).

Based on a study by Chotimarkorn and Silalai (2008), addition of rice bran oil to soybean oil can decrease the oil deterioration from hydrolytic rancidity and oxidative rancidity in fried product during frying and storage. Addition of sesame oil and rice bran oil during deep frying can contribute to the anti-rancidity effects which can improve the frying stability on canola oil (Farhoosh and Kenari, 2009). A study by Kochhar (2002) shown that rice bran oil exhibits excellent frying stability and contributes a pleasant flavour to the fried food. The oxidative stability of rice bran oil was found to be equivalent to peanut oil when tested in simulated deep frying conditions (Orthoefer, 1996). Kochhar (2000) reported that the blend of specially refined rice bran oil and 'dedicated' sesame oil may be used to fortify less stable soft oils such as rapeseed oil, sunflower oil and soybean oil. This small addition (4-6%) of the oil blend will improve not only frying oil stability but also enhance the shelf life and flavour quality of the fried foods.

2.3 Preparation of Rice Bran Oil
2.3.1 Stabilization of Rice Bran

Stabilization of rice bran improved the shelf life, nutrient availability and microbiological safety of the bran (Bidlack, 2000). Rice bran contains enzymes, microorganisms and insects are the major causes of deterioration of rice bran.
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