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PHYSICOCHEMICAL CHARACTERISTICS OF RICE BRAN SOURDOUGH FERMENTED WITH LACTOBACILLUS PLANTARUM FOR BREADMAKING

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PHYSICOCHEMICAL CHARACTERISTICS OF RICE BRAN SOURDOUGH FERMENTED WITH *LACTOBACILLUS PLANTARUM* FOR BREADMAKING

By

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PHYSICOCHEMICAL CHARACTERISTICS OF RICE BRAN SOURDOUGH FERMENTED WITH *LACTOBACILLUS PLANTARUM* FOR BREADMAKING

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September 2014

Chair: **Sharifah Kharidah Syed Muhammad, PhD**

Faculty: **Food Science and Technology**

A general growing awareness of healthy lifestyle increased the interest of the food industry in the market of high fiber products. Rice bran, an agro-byproduct obtained from outer rice layers, could offer a new variety of baked goods with high fiber content. However, bran supplementation usually can cause severe problems to the quality of final products. Thus, supplementation with bran requires changes in processing techniques for the production of baked goods with good consumer quality. One of the techniques being employed is fermentation and this study was carried out to optimize the fermentation conditions of rice bran sourdough. This was then followed by evaluation of the rice bran sourdough functionality.

Rice bran used in this study contained 10.9% moisture, 16.1% fat, 12.7% protein, 8.8% ash, 22.4% insoluble dietary fiber, 1.3% soluble dietary fiber and 27.8% carbohydrate. The use of lactic acid bacteria (LAB) and yeast starter cultures in the fermentation process resulted in slight differences among the fermentative end product characteristics of the sourdough. These characteristics were highly influenced by the LAB strains used. *Lactobacillus plantarum* was better than *Lactobacillus brevis* and *Lactobacillus sanfranciscencis* at producing the desired pH, total titratable acidity (TTA), organic acids, fermentation quotient and soluble sugars required in sourdough preparation. A response surface methodology (RSM) and central composite design (CCD) were employed to obtain the optimum fermentation conditions for obtaining acidic properties and antioxidant phenolic compounds in rice bran sourdough incorporated with *Lactobacillus plantarum*. The acidity values found showed that the fermentation temperature and time at 33℃ and 12.5 hours, respectively, were able to produce optimum pH (pH 3.5 to 4.5) and total titratable acidity (16 to 22 ml of 0.1M NaOH). Total phenolic compounds increased in parallel with increasing fermentation temperature and time. Rice bran sourdough gave breads with significantly higher loaf

specific volume (4.65cm^3/g) and crumb softness (3.54) compared to rice bran bread and wheat bran sourdough bread. Sourdough was able to maintain the freshness and prolong shelf life of the bread. Supplementation of the bread dough with bran darkened the final product. Rice bran sourdough bread got the lowest score, in terms of overall acceptance, when compared to wheat bran sourdough, rice bran, wheat bran and control (no bran) breads in sensory evaluations.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

CIRI-CIRI FIZIKAL DAN KIMIA DOH MASAM DEDAK BERAS DITAPAI OLEH *LACTOBACILLUS PLANTARUM* UNTUK PROSES PEMBUATAN ROTI

Oleh

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Kesedaran pengguna yang semakin meningkat terhadap gaya hidup sihat meningkatkan kepentingan industri makanan dalam pasaran produk serat yang tinggi. Dedak beras, salah satu hasil sampingan pertanian yang diperolehi daripada lapisan luar biji beras, menawarkan potensi untuk pelbagai produk bakeri berasaskan bijirin dengan kandungan serat yang tinggi. Walaubagaimanapun, penambahan dedak bijirin dalam formulasi biasanya memberi kesan negatif kepada kualiti produk tersebut. Oleh itu, penggunaan dedak memerlukan perubahan dalam teknik pemprosesan untuk menghasilkan produk bakeri dengan kualiti pengguna yang baik. Kajian ini telah dijalankan untuk mengoptimumkan keadaan penapaian dedak beras dan menilai fungsi doh masam dedak beras ke atas produk bakeri.

Dedak beras yang digunakan dalam kajian yang mengandungi 10.9% kelembapan, 16.1% lemak, 12.7% protein, 8.8% abu, 22.4% serat tidak larut, 1.3% serat larut dan 27.8% karbohidrat. Penggunaan bakteria asid laktik dan yis menyebabkan sedikit perbezaan ke atas cirri-ciri produk penapaian antara doh masam dedak beras. Ciri-ciri produk akhir penapaian yang lebih dipengaruhi oleh jenis mikroorganisma yang digunakan. *Lactobacillus plantarum* lebih baik berbanding *Lactobacillus brevis* dan *Lactobacillus sanfranciscencis* dalam menghasilkan pH yang dikehendaki (pH 3.5- 4.5), TTA (16-22 ml 0.1M NaOH), asid organik, hasil penapaian dan gula terurai yang diperlukan untuk menyediakan doh masam yang baik. *Response surface methodology* (RSM) dan *central composite design* (CCD) telah digunakan untuk mendapatkan keadaan penapaian optimum doh masam dedak beras yang ditapai bersama *Lactobacillus plantarum*. Nilai keasidan yang diperolehi menunjukkan bahawa suhu penapaian dan masa pada 33℃ selama 12.5 jam mampu menghasilkan pH dan jumlah

keasidan yang optimum. Sebatian fenolik meningkat selari dengan peningkatan suhu dan masa penapaian. Doh masam dedak beras meningkatkan jumlah isipadu buku roti (4.65cm^3/g) dan tahap kelembutan (3.54) berbanding roti dedak beras dan roti doh masam dedak gandum. Doh masam mampu mengekalkan kesegaran dan memanjangkan jangka hayat roti. Tambahan dedak meyebabkan warna roti bertambah gelap. Roti berasaskan doh masam dedak beras mendapat skor terendah bagi penerimaan keseluruhan apabila dibandingkan dengan roti doh masam dedak gandum, roti dedak beras dan dedak gandum, serta roti kawalan dalam penilaian deria rasa yang dijalankan.

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I certify that an Examination Committee has met on _____ to conduct the final examination of **Hanis Syazwani Mat Gani** on her Master thesis entitled "**Physicochemical Characteristics Of Rice Bran Fermenting With *Lactobacillus plantarum* In Breadmaking**" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. Committee recommends that the student be awarded the Master of Science (Food Science).

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Variance
CCD	Central Composite Design
CFU	Colony Forming Units
FQ	Fermentation Quotient
GAE	Gallic Acid Equivalents
HPLC	High Pressure Liquid Chromatography
IDF	Insoluble Dietary Fiber
LAB	Lactic Acid Bacteria
L. brevis	*Lactobacillus brevis*
L. plantarum	*Lactobacillus plantarum*
L. sanfranciscencis	*Lactobacillus sanfranciscencis*
RID	Refractive Index Detector
RSM	Response Surface Methodology
S. cerevisiae	*Saccharomyces cerevisiae*
SDF	Soluble Dietary Fiber
TDF	Total Dietary Fiber
TTA	Total Titratable Acidity

CHAPTER 1

INTRODUCTION

Increased consumer consciousness of health has brought to the growth of fiber rich food products. The advantage of fibers as functional elements has been appraised by researchers (Rodriguez et al., 2006; Warrand, 2006). These studies proved that dietary fiber is one of important ingredients in the formulation of functional foods. These days the demand for dietary fiber is greatly competitive. Bakery products are consumed in large quantities daily and they provide a convenient vehicle for delivering dietary fiber and other healthy compounds to consumers. European legislation (Regulation (EC) 1924/2006, 2006) announced that bread enriched with fiber can be categorized as high fiber goods and thus able to encourage valuable physiological effects when consumed if it contains at least 6 g of fiber in 100 g of product.

However, the foremost challenge when adding the fiber into baked goods, especially in such amounts that benefits health, is its undesirable effects on the final product quality leading to low consumers' acceptance. By adding fiber into a dough, it can cause technological changes including increase in water absorption and development time (Ajila et al., 2008; Penella et al., 2008; Stojceska and Ainsworth, 2008; Anil, 2007; Sudha et al., 2007; Wang et al., 2002), decrease in extensibility of dough (Barros et al., 2010), the manageability of the dough (Mart ńez-Cervera et al., 2011), (iv) reduction in loaf volume and production of denser less aerated structure (Katina, 2003), generation of harder and darker crumb (Stojceska and Ainsworth, 2008), and changes in appearance, taste and other sensory properties (Ayadi et al., 2009; Peressini and Sensidoni, 2009; Ajila et al., 2008; Stojceska et al., 2008; Anil, 2007; Larrea et al., 2005; Wang et al., 2002; Grigelmo-Miguel et al., 2001).

Therefore, many approaches have been employed to improve the quality of high fiber baked products incorporated with bran. Salmenkallio-Marttila et al. (2001) suggested that preferment bran was effective in improving volume and softness of high-fiber bread. Usage of commercial enzyme mixtures or pre-soaking of the bran can overcome the negative effects of bran on bread texture (Katina et al., 2006a). Sourdough practice can be utilized effectively in high-fiber baking. Sourdough is primarily used to improve product volume and texture (Clarke et al., 2002; Crowley et al., 2002; Corsetti et al., 2000), flavour (Thiele et al., 2002; Hansen and Hansen, 1996), nutritional values (Liljeberg et al.,1995; Liljeberg and Bjorck, 1994) and shelf-life (Dal Bello et al., 2006; Lavermicocca et al., 2003, 2000; Corsetti et al., 1998). Fermentation with well-characterized starter cultures— yeast or lactic acid bacteria (LAB)—is a potential means to improve the palatability and processability of brans and wholemeal flours (Salovaara, 2004; Katina et al., 2006). Furthermore, bran fermentation could assist in microflora management and improve the microbiological safety of bran. This is important, because

brans are known to contain more micro-organisms than endosperm flours, and they could also be a source of spoilage bacteria and fungi (Rosenquist and Hansen, 1995).

Rice bran, an agricultural waste, is regarded as a rich source of dietary fiber with dietary fiber content reported to be 40% (Sudha et al., 2007). Tanaka et al. (2006) reported that as bran and rice is in a ratio of 10% (wt), hence annual output of rice bran comes to about 9×10^5 tonnes. Even though the nutritional value of rice bran is well noticed, it is still under-utilized in many rice producing countries of the world including Malaysia. The bran is either burnt off, used as animal feed or undergoes extraction for its oil. This is why it would be interesting to develop nutritionally optimized cereal foods and new ingredients from rice bran.

The general aim of this study was to prepare and investigate the functionality of rice bran sourdough. The specific objectives, however, were as follows:

i. To evaluate biochemical changes produced in rice bran sourdough fermented using different strains of lactic acid bacteria (LAB) and yeast, *Saccharomyces cerevisae*
ii. To optimize the time and temperature of rice bran sourdough fermentation for improvement of the acidic properties and total phenolic compounds
iii. To evaluate physical characteristics and sensory attributes of bread prepared using fermented rice bran sourdough with LAB and yeast

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