UNIVERSITI PUTRA MALAYSIA

QUALITY CHARACTERISTICS OF RICE BRAN OIL AND THE UTILIZATION OF RICE BRAN FROM SELECTED MALAYSIAN RICE VARIETIES

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By

ZALEENAH BT ZAINUDDIN

Thesis Submitted in Partial Fulfilment of the Requirements for the Degree of Master of Science in the Faculty of Food Science and Biotechnology Universiti Pertanian Malaysia

January 1990

It is hereby certified that we have read this thesis entitled 'Quality Characteristics of Rice Bran Oil and the Utilization of Rice Bran from Selected Malaysian Rice Varieties' by Zaleenah Zainuddin, and in our opinion it is satisfactory in terms of the scope, quality, and presentation as fulfilment of the requirements for the degree of Master of Science

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ACKNOWLEDGEMENTS

I wish to express my appreciation to my Supervisor Dr. Mohd. Nasir Azudin for his constant guidance, support and excellent supervision for the success of this project.

I wish to thank Dr. Mary Ann Augustine and Dr. Jinap Selamat for their valuable comments and assistance.

I am grateful to all the staff members of the Faculty of Food Science and Biotechnology (FSTM) for their kindness and hospitality shown to me throughout this research.

My special thanks are extended to Mr. Gapor Mohd. Top and Mrs. Rokiah of PORIM for conducting the analysis of tocopherols in rice bran oil.

Thank you also goes to Mr. Ahmad Mohd. Zain of the Faculty of Agricultural Engineering for allowing me the use of the milling equipments; MARDI, Parit, for the samples of paddy; LPN, Sekinchan, for providing rice bran. Dr. Abdullah Abu Bakar of the Faculty of Food Science and Biotechnology for providing rice bran oil from Japan and Mr. Kazuo Okamoto for translating Japanese journals.

Lastly, I wish to take this opportunity to express my deepest acknowledgement to all the members of my family and those who helped me in one way or another during this time.

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LIST OF ABBREVIATIONS

ASRCT	Applied Science Research Centre of Thailand
FAME	Fatty acid methyl ester
FFA	Free fatty acid
IRRI	International Rice Research Institute
IUPAC	International Union of Pure and Applied Chemistry
LPN	National Paddy Board (Malay = Lembaga Padi Negara)
MARDI	Malaysian Agricultural Research and Development Institute
PORIM	Palm Oil Research Institute of Malaysia
SIRIM	Standard Industrial Research Institute of Malaysia
W/m°C	watts per metre degree Centigrade

Abstract of thesis submitted to the Senate of Universiti Pertanian Malaysia in partial fulfilment of the requirements for the degree of Master of Science.

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ZALEENAH BT ZAINUDDIN

JANUARY, 1990

Supervisor : Dr. Mohd. Nasir bin Azudin
Faculty : Food Science and Biotechnology

This study evaluated the quality of crude rice bran oil and rice bran from ten Malaysian rice varieties and commercial refined rice bran oil from Japan and India. The utilization of rice bran in bread was also studied. The rice bran was steamed(S), autoclaved(A) or left untreated(U) before oil extraction to investigate the effect of bran stabilization on oil quality.

Stored rice bran (U) deteriorated rapidly and attained 10% FFA 34 hours after milling. The oil yield from bran was 8.1-15.4%(U), 11.4-21.2%(S) and 18.4-24.4%(A). The predominant unsaturated fatty acids were oleic acid (34-43%) and linoleic

acid (35-42%) in steamed bran. Unsaturated fatty acid content ranged from 73-78%(U) and 74-80%(S).

FFA content ranged from 5.5-8.5%(U), 3.2-7.8%(S) and 2.6-4.7%(A), while iodine value ranged from 92-101(U), 92-107(S) and 94-99(A). The colour of crude oil at Y+5R ranged from 9-27. Refined oil had FFA less than 0.1%, iodine value of 98-107 and colour value of 1.5-7.0. Autoclaved bran retained 1046 ppm (MR 84) tocopherols where γ-tocopherol and tocotrienols were predominant.

Rice bran of Malaysian varieties contained 12.2-15.8% crude protein. Major amino acids were glutamic acid, lysine, glycine and methionine. Varieties MR 7 and MR 10 had crude fat, crude fibre and total ash contents of 24.4% and 19.4%, 8.1% and 9.5%, and 12.2% and 10.8% respectively. They also had 1.5 mg/g calcium, 14 mg/g and 12 mg/g potassium, 23 mg/g and 20 mg/g magnesium and 160 µg/g and 250 µg/g sodium respectively. Rice bran incorporated in bread (6%) was equally acceptable as wheat bran bread (12%).

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia untuk memenuhi sebahagian daripada syarat keperluan untuk Ijazah Master Sains.

**CIRI-CIRI KUALITI MINYAK DEDAK BERAS
DAN PENGGUNAAN DEDAK BERAS
DARIPADA JENIS BERAS YANG TERPILIH**

Oleh

ZALEENAH BT ZAINUDDIN

JANUARI, 1990

Penyelia : Dr. Mohd. Nasir bin Azudin
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Kajian ini menganalisa ciri-ciri minyak dedak beras mentah dan dedak beras dari sepuluh jenis beras Malaysia serta minyak dedak beras komersial dari Jepun dan India. Penggunaan dedak beras dalam roti juga telah dikaji. Kesan penstabilan dedak beras ke atas mutu minyak yang dikaji dibuat dengan mengekstrak minyak dari dedak yang dikukus(S), diautoklaf(A) dan yang tidak diberi rawatan(U).

Dedak beras (U) yang disimpan mencapai 10% asid lemak bebas dalam masa 34 jam. Minyak yang didapati dari dedak adalah 8.1-15.4%(U), 11.4-21.2%(S) dan 18.4-24.4%(A). Asid lemak tidak tepu yang tertinggi adalah asid olik (34-42%) dan

asid linolik (35-42%) dalam dedak yang dikukus. Kandungan asid lemak tidak tepu adalah dalam lingkungan 73-78%(U) dan 74-80%(S).

Asid lemak bebas dalam minyak mentah adalah 5.5-8.5%(U), 3.2-7.8%(S) dan 2.6-4.7%(A) sementara nilai iodin adalah 92-101(U), 92-107(S) dan 94-99(A). Warna minyak mentah dalam ukuran Y+5R adalah antara 9-27. Minyak yang ditapis mempunyai asid lemak bebas kurang dari 0.1%, nilai iodin 98-107 dan nilai warna 1.5-7.0. Dedak yang diautoklaf masih mempunyai 1046 ppm tokoferol (MR 84) di mana τ-tokoferol dan tokotrienol adalah yang terbanyak.

Dedak beras jenis Malaysia mengandungi 12.2-15.8% protin kasar. Asid amino yang terbesar kandungannya adalah asid glutamik, lisin, glisin dan metionin. Jenis MR 7 dan MR 10 mempunyai kandungan lemak kasar, serabut kasar dan abu berjumlah 24.4% dan 19.4%, 8.1% dan 9.5% serta 12.2% dan 10.8% masing-masing. Kedua-duanya juga mempunyai 1.5 mg/g kalsium, 14 mg/g dan 12 mg/g kalium, 23 mg/g dan 20 mg/g magnesium serta 160 µg/g dan 250 µg/g natrium masing-masing. Roti yang ditambah dedak beras (6%) mempunyai penerimaan ahli-ahli panel sama seperti roti dedak gandum (12%).

CHAPTER ONE

INTRODUCTION

Rice bran is a by-product of rice milling and polishing. It is normally sold to poultry farmers as animal feed. However, several countries have utilized this by-product to produce high grade edible oil.

Rice bran oil is termed as an exotic oil since it reflects high quality characteristics and can be used for both edible and industrial purposes, from salad oil to moisturizing creams.

Countries like Japan, India, China, Thailand and Burma have been utilizing this waste product to produce oil for local consumption. The estimated total world production of rice bran oil in 1984 was 412,093 tonnes compared to 219,710 tonnes in 1975 (FAO, 1983).

Malaysia produced 1.73 million tonnes paddy in 1983 and 1.96 million tonnes of paddy in 1985. The paddy was milled locally as the rice was for use within the country. Thus, the bran and polish which were by-products of milling amounted to 176400 tonnes (according to 1985 estimates) with a 9% degree of milling that is normally practised in paddy processing complexes. If this bran was extracted for oil, an estimated 26460 tonnes of crude oil could be produced based on 15% oil content in rice bran (Malaysian Economic Report, 1989).

As the annual production of paddy increases, the estimated untapped amount of oil in rice bran also increases and is lost through utilization in animal feed or through burning with husks.

This study evaluated the quality of bran oil from ten Malaysian rice varieties. The rice bran samples were treated under different conditions and the quality characteristics of oil were compared with commercial rice bran oil samples obtained from Japan and India, and other edible oils. The quality deterioration of rice bran on storage, the quality of defatted rice bran and the feasibility of incorporating rice bran in bread were also studied.

CHAPTER TWO

LITERATURE REVIEW

The Rice Caryopsis

The rice caryopsis is enveloped by the hull (lemma, palea and the larger lemma) as in Figure 1. The cells of the hull are lignified and brittle in nature, thus, acting as a protective layer against insect infestation and fungal and mechanical damage to the caryopsis. Both lemma and palea consists of four structural layers : 1) an outer epidermis, cuticled ; 2) sclerenchyma or hypoderm fibres with lignified cell walls ; 3) spongy parenchyma cells, and ; 4) an inner epidermis (Houston, 1972; Juliano,1985).

Between the hull and endosperm is the caryopsis coat consisting of the crushed cells of the pericarp, seed coat (tegmen) and nucellus. The pericarp has several layers of cells about 10 µm thick. The seed coat is a layer of cell whose inner side is cuticled (0.5 µm). The pigment layer in coloured rice is normally about 2.5 µm thick inclusive of a 0.8 µm thick cuticle (Juliano, 1972).

The embryo is on the ventral base of the grain. It consists of the scutellum (cotyledon) which sheaths the coleoptile. The hypocotyl (short stem) joins together the

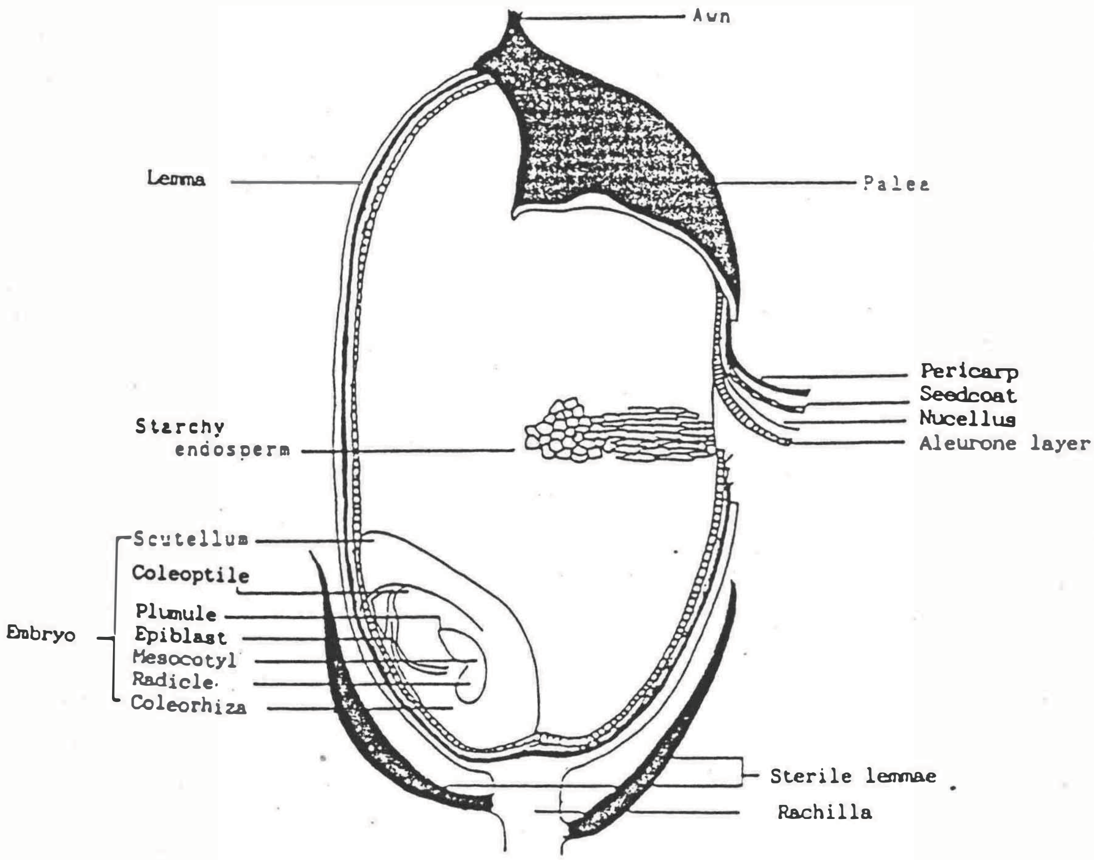

Figure 1. Diagrammatic Representation of the Rice Caryopsis

plumule (embryonic leaves) and the radicle (embryonic primary root). The coleorhiza is an extension of the epiblast.

The aleurone layer is 1-7 cells thick. Hoshikawa (1976) found that the thickness of the aleurone layer depends on cultivars ; coarser or bolder, short-grain cultivars had more cell layers than slender, long-grain cultivars. The aleurone layer consists of aleurone grains (protein bodies) and spherosomes (lipid droplets). The protein bodies contain phytate and nyacitin (Tanaka et al., 1973). Ogawa et al. (1975) found the globoids (1-2 µm in size) separable from the aleurone layer. Organelles present in the aleurone layer are microbodies, nucleus, mitochondria, endoplasmic reticulum, vesicles and plastids (Juliano and Bechtel, 1985).

The starchy endosperm contains a subaleurone layer rich in large spherical protein bodies (1-2 µm in diameter), small spherical protein bodies (0.5-0.75 µm in diameter) and crystalline protein bodies (2-3.5 µm in diameter). The central endosperm is composed of compound starch granules (3-9 µm in diameter) which are large and polygonal surrounded by protein resembling the large spherical protein bodies (Bechtel and Pomeranz, 1977).

Milling

To obtain edible rice, the husk or hull is removed to yield brown rice. In commercial operation, rough rice or paddy, is first cleaned of contaminants before dehusking by shellers (horizontally spaced rotating abrasive stones). In modern mills, rubber rollers or rubber-belt shellers are used for this purpose to decrease the breakage of grains during dehulling (Swamy et al., 1984).

The bran layer of brown rice is abraded to leave a nearly white kernel. The germ is usually removed with the bran. The rice is then passed through the brushes to remove the polish (also called the white bran).

The bran contains more of the pericarp, seed coat, nucellus, aleurone layer and germ than the polish, which contains more of the starchy endosperm. Bran removal is about 8-9% of rough rice while polish is about 2-3% of rough rice. Assuming 20% hulls and 80% brown rice, these values correspond to 6-11% bran and 2.5-3.8% polish in brown rice.

The degree of milling of rice is a measure of the extent to which the germ and bran layers have been removed from the endosperm. The protein content, fat or oil, and soluble carbohydrates of the bran are derived from the inner aleurone cells and the embryo, whereas, the starch content is derived from the endosperm cells which adhere to the outer bran layers which are removed during milling. Therefore, a higher degree of milling indicates greater loss of fat, protein, mineral content and vitamins from the bran layers when rice is milled (Hogan and Deobald, 1965).

During milling, breakage of the grain is minimised as broken grains indicate quality deterioration of the grain. Quality of a particular rice is determined by the measurement of head yield or head rice (% of whole kernels). The large broken grains, or brokens, are classified as second heads, while the small brokens are screenings and brewers' rice. Dhaliwal et al. (1986) found that late sowing and transplanting dates decreased the yield of head rice due to weak kernels.

Broken rice grains are prevalent during milling among chalky, cracked and immature rice (Bhattacharya, 1969). Other factors are grain drying, moisture content, infestation, shape, hardness of grain and the type and design of milling equipments. Autrey et al. (1955) showed that rice breakage was influenced by milling conditions - relative humidity, temperature and the extent of milling.

Medium and slender grains were found to have greater breakage during dehulling (Swamy et al., 1984). Long-grain milled rice was more susceptible to breakage than medium-grain milled rice (Pomeranz and Webb, 1985).

Rice Bran

Enzymes

Raw rice bran contains active lipolytic enzymes - lipases - which hydrolyses the triglycerides and releases free fatty acids (FFA). The lipolytic action of the enzymes are responsible for the deterioration of the raw rice bran and oil during storage as they cause rancidity due to the increase of FFA.

The distribution of lipolytic acylhydrolase activities in the rice grain is : rice bran lipase, 57% ; bran galactolipase, 35% ; bran phospholipase, 2% ; milled rice lipase, 1% ; milled rice galactolipase, 2% ; and milled rice phospholipase, 3% (Matsuda and Hirayama, 1975).

Takano *et al*. (1986) found the ratio of the activities of these lipolytic enzymes to be lipase : phospholipid acyl-hydrolase : phospholipase C : phospholipase D = 100 : 24 : 35 : 39. Matsuda and Hirayama (1973) confirmed the ratio of activities of lipase : galactolipase : phospholipase to be as 100 : 64 : 9.

Rice bran lipase consists of Lipase II which exhibits a high specificity toward triglycerides having short carbon chain fatty acids is also capable of hydrolysing the ester bonds in the rice bran oil (Aizono *et al*., 1976). The hydrolysis rate