PRODUCT DEVELOPMENT OF BLACK UPLAND RICE BREAD WITH MANGOSTEEN

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ABSTRACT

Black upland rice bread with mangosteen was the combination of the black upland rice and dried mangosteen which was developed to determine its nutritional values, shelf life and consumer acceptance. Eight formulations of black upland rice bread with mangosteen were firstly developed and formulation 4, 5, and 6 were selected from them by using Balanced Incomplete Block (BIB) rating test. Out of three formulations, formulation 5 that contains 75% wheat flour and 25% black upland rice powder was chosen as the best formulation by using 7 point hedonic test. Formulation 5 also contained highest mean score in the attribute of aroma, taste, texture, softness of crumb and overall acceptance. The formulation 5 contained 30.3400 ± 1.4080% moisture, 1.370 ± 0.0361% ash, 8.7667 ± 0.0577% protein, 5.5967 ± 0.1210% fat, 1.5533 ± 0.5300% crude fibre and 52.3733 ± 0.7995% carbohydrate. It also contains 298.04 kcal per 100g. Formulation 5 consisted of 55.6667 ± 1.5275% volume and 1.5000 ± 0.0361% specific volume. The microbiological test showed that the product only can be consumed until day three out of five storage days with colony number 3.30×10^4 for bacteria count and 3.05×10^3 for yeasts and mould count. In the physicochemical test, the moisture content and pH of the sample were decreased significantly from day zero to day four. In paired comparison test, the attribute of colour, aroma, taste, texture, softness of crumb and overall acceptance was getting worse with the longer storage period. In the consumer test, there were 72% of people will purchase the product if it is sold in the market whereas 20% of people maybe will purchase and 8% of people are not going to purchase.

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ABSTRAK

PENHASILAN PRODUK ROTI BERAS BUKIT HITAM DENGAN MANGGIS

Roti beras bukit hitam dengan manggis terdiri daripada beras bukit hitam and manggis kering dimana pembangunan ini dapat menentukan nilai nutrisi, jangka hayat and penerimaan penggunanya. Lapan formulasi roti beras bukit hitam dengan manggis dibangunkan terlebih dahulu dan formulasi 4, 5 dan 6 telah dipilih dengan melalui ujian pemeringkatan BIB. Daripada tiga formulasi tersebut, formulasi 5 yang mengandungi 75% tepung gandum dan 25% serbuk beras bukit hitam telah dipilih menjadi formulasi terbaik dengan menggunakan ujian hedonic 7 titik. Formulasi 5 juga mempunyai nilai min skor yang tertinggi dari segi ciri-ciri aroma, rasa, tekstur, kelembutan isi roti dan penerimaan keseluruhan. Formulasi terbaik ini mengandungi 30.3400 ± 1.4080% kelembapan, 1.370 ± 0.0361% abu, 8.7667 ± 0.0577% protein, 5.5967 ± 0.1210% lemak, 1.5533 ± 0.5300% serabut kasar and 52.3733 ± 0.7995% karbohidrat. Ia juga mempunyai 298.04 kcal untuk 100g. Formulasi 5 mengandungi 55.6667 ± 1.5275% isipadu dan 1.5000 ± 0.0361% isipadu spesifik. Ujian mikrobiologi menunjukkan produk ini hanya boleh dimakan sampai hari ketiga daripada lima hari penyimpanan dengan koloni nombor bagi kiraan bacteria ialah 3.30×10^4 dan 3.05×10^3 untuk kiraan yis dan kulat. Dalam ujian fizikokimia, kandungan kelembapan and pH bagi sampel adalah menurun dari hari sifar ke hari keempat. Dalam ujian sensori perbandingan berganda, ciri-ciri warna, aroma, rasa, tekstur, kelembutan isi roti dan penerimaan keseluruhan semakin menurun dengan pertambahan hayat penyimpanan. Dalam ujian pengguna, terdapat 72% akan membeli produk ini jika dijual dalam pasaran manakala 20% mungkin akan beli dan 8% tidak akan beli produk ini.

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LIST OF ABBREVIATION

℃	Celcius
g	gram
mg	milligram
mm	millimeter
ml	milliliter
kcal	kilocalories
kJ	kilojoules
%	percentage
±	plus minus
AOAC	Association of Official Analytical Chemists
BIB	Balanced Incomplete Block
BC	Before century
CFU	Colony Forming Unit
Est	Estimate
FAO	Food and Agriculture Organization
IRRI	International Rice Research Institute
MOH	Ministry of Health
PCA	Plate count agar

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PDA	Potato dextrose agar
TPC	Total plate count

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CHAPTER 1

INTRODUCTION

1.1 Background

Bread is a kind of nutritional bakery product which made from the combination of milled grain flour and liquid or other solids ingredients, normally but not always rise up by using leavening agents before baking (Rochelle, 2001). The first bread was developed in around 10,000 years BC or over 12,000 years in the past. Egyptians are the pioneers who make the bread and start to use the yeasts as leavening agents in the processing since about 6000 years BC (Mondal and Datta, 2008). Since then, a lot of modification and development either in the production or distribution of bread was done and thus contributed to many types of breads. Nowadays, bread has become the main staple food in the whole world.

In Malaysia, bread has been labeled as the most popular substitute of rice and becomes one of the top ten weekly consumed foods (Norimah*et al.*, 2008). Based on Norimah*et al.* (2008), bread is a food item which consumed both in the daily and weekly. In their data, the percentage of prevalence in daily consumption is 17.11% and total amount consumed daily is about 3 slides. The databases were collected based on sex, geographic and age group with some comparisons between them; however, the data showed no big difference between them. These show that bread has a quite high market demands in Malaysia.

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There are several reasons that influence the bread consumption in Malaysia. The main factor is nutritional values of bread are almost similar to rice in which both are high in carbohydrates and protein contents. In addition, dish preparation is more time consuming and waste energy but bread is a quick meal and can be consumed conveniently. Bread can be bought or get easily too from places such as hypermarket, minimarket, café, retail shops, canteen, petrol station and so on. Also, different types of bread products are developed from bread industry to meet consumers' demands. Thus, the bread is produced, modified and growth from times to times to ensure trends are followed (Chin, 2006). In this project, black upland rice and mangosteen are added into the bread in order to meet the health and convenience trend.

Black upland rice consists of higher amounts of nutritional value which is important and necessary in human body if compared with other normal white rice. This is due to its unmilled rice bran. Black upland rice is strong in excellent nutty flavour or unique texture. It is also rich in macronutrient and micronutrient such as protein, fat, crude fibre, lysine, vitamin B_1, calcium, iron, zinc and phosphorus (Schiller *et al.,* 2006).

Among other varieties of rice bran, black rice bran consists of highest antioxidant compounds. For example, black rice bran contains highest amount of β-carotene with values reaching up to 0.22mg/kg (Frei and Becker, 2004). According to Frei and Becker (2004), antioxidants have beneficial values to human body in which they are able to protect body tissue from oxidative damage. Substitution of black upland rice flour is also contributing to the high level of dietary fibre in bread product. In general, the advantages of high levels dietary fibre diets have become familiar which involved in reducing the level of serum cholesterol, blood pressure, risk of heart disease, risk of various cancer, as well as weight loss and control (Rosentrater, 2011). Besides, rice flour is generally gluten-free. Partially substitute of black upland rice flour

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in bread capable of reducing the content of gluten in bread. In addition, partially substitute of black upland rice brings to a higher visibility due to the high demand of bread.

Mangosteen is a kind of high nutrient and well-accepted tropical fruit among people. It consists of high level of antioxidant, vitamins and minerals especially in term of vitamin C, vitamin E, calcium and phosphorus which directly increase the nutritional value of the bread (Yaacob and Tindall, 1995). It is also excellent in taste and aroma. Normally, it is freshly eaten instead of being produced into other type of products. In the market, the commercial product of mangosteen is still very few. Those products are included mangosteen juice, mangosteen candy, mangosteen jam and so on. Thus, the addition of mangosteen as an ingredient in the bakery product is considered a new category for the product of mangosteen. Besides, the price of the mangosteen is affordable if compared with other fruit such as dragon fruit where mangosteen is cost RM2.50 per kilogram while dragon fruit is RM7.00 per kilogram.

1.2 Objectives

1. To develop the best formulation of black upland rice bread with mangosteen by using sensory tests.
2. To determine the nutritional values of best formulation for black upland rice bread with mangosteen by using proximate analysis.
3. To determine the shelf life of best formulation for black upland rice bread with mangosteen by using microbiological, physicochemical and paired comparison test.
4. To determine the consumer acceptance of black upland rice bread with mangosteen by using consumer test.

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CHAPTER 2

LITERATURE REVIEW

2.1 Bread

2.1.1 Background of Bread

Bread is one of the world wide dietary staple foods (Fardet*et al.*, 2006). Bread is an ideal food and well accepted due to its high availability, high nutritional value and low cost. Bread also becomes a source of irreplaceable nutrients for the human body aside from providing energy source. Generally, bread consists of little fat, high quantities of starch, dietary fiber and cereal protein. In addition, bread also contains high amount of B-complexes vitamins and minerals such as magnesium, calcium and iron (Isserliyska *et al.*, 2001).

Bread is defined as a baked product that produced by the flour, which is being moisten, kneaded, fermented and rises before the baking process (Neusner, 1999). It can be composed by using simple formulation which involved the mixture of flour, water, leavening agent (yeast or chemicals) and salt (sodium chloride) (Dewettinsk*et al.*, 2008). Also, other minor ingredients such as shortening agent, sugar, emulsifiers, bread improver, milk powder and so on will be added if necessary in order to improve the bread quality. Every ingredient has its own function in bread and any changes towards the ingredients will directly affect the bread's quality. Thus, the best formulation on the ingredients is required to obtain high-quality bread.

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2.1.2 Types of Bread

Bread can be produced from elastic dough, rich dough and rolled-in yeast dough. Elastic dough can be divided into three types based on the fat and sugar content in the product. The first type of elastic dough is hard crust roll or bread. French and Italy bread, Kraiser roll and pizza are the examples of hard crust roll or bread. The second type of elastic dough is soft bread or roll such as white or whole meal bread and dinner roll. This type of bread consists of higher fat and sugar content and sometimes egg and milk powder are added too. The third type of elastic dough is bread that produced by using cereal such as rye bread.

Rich dough contains higher fat, sugar or egg content if compared with the elastic dough product. The rich dough product can be divided into less sweet bread or roll and sweet bread or roll. The examples of less sweet bread or roll included rich fat but less sweet brioches and dinner roll. Meanwhile, the examples of sweet bread or roll included roll and bun which are high in fat and sugar content or sweet filling.

The rolled-in yeast dough is produced through the addition of fat in form of many layers by using scrolling or multiplication technique. The fat layer is overlapping with dough in order to produce the crispy texture. There are two types of rolled-in yeast dough produce are being produced, they are croissant for less sweet rolled-in yeast dough product and pastry Danish for sweet rolled-in yeast dough product.

Special dough product included fried bread such as donut and steam bread. The main difference between these two products is the used of heating method (Hui and Corke, 2006).

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2.1.3 Basic Ingredients and Their Functions

The basic ingredients for the bread formulation are wheat flour, yeast, salt, water, brown sugar, margarine and egg.

a. Wheat Flour

Wheat flour is the most significant ingredients in a bread making process as it modulates the specific characteristics of bakery products (Mondal and Datta, 2008). It is obtained by milling of the wheat grain. Normally, the wheat flour that is suitable for bread making is produced by milling the hard wheat where the wheat can be divided into hard and soft wheat based on its hardness of kernel (Murano, 2003). It consists of protein (10-12%), starch (68-76%) and other carbohydrates, ash, non-starch polysaccharides (2-3%), in particular arabinoxylans (AX), lipids (1-1.5%), water (11-14%), small amounts of vitamins, minerals and enzymes (Finogi, 2008).

Hard wheat flour, also known as strong flour that consists of high protein content and most of it is high-quality gluten. Gluten is the composite of glutenin and gliadin. The properties of these two subunit proteins are important in determine the mixing and baking properties of dough (Cauvain, 2003). The native polymers of the glutenin subunits make the contribution to dough strength while the gliadin proteins contribute to the viscosity and extensibility of the dough (Carver, 2009). The combination of glutenin and gliadin during mixing will produce the elastic protein gluten network which resulting in an elasticity, viscosity and cohesiveness dough (Parker, 2003). The dough has the ability to form thin sheets that will able to retain gas and produce a light baked product (Gujral and Rosell, 2004). In addition, strong flours usually have a high water-absorption value and require a longer mixing time to fully develop, but they are tolerant of over-mixing.

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b. Yeast

Yeast is a living microorganism which belongs to the fungi family of plants. However, due to the lacking of green pigment, the chlorophyll, yeast unable to produce food itself through the carbon from carbon dioxide. Instead, yeast uses sugar or carbohydrate during food production (Fance, 1966; Hunter *et al.,* 2007). It converts the simple sugar from carbohydrate into alcohol (ethanol) and gas (carbon dioxide) during the fermentation process (Suas, 2009). Due to this process, yeast also known as *Saccharomyces*, which means sugar fungus (Fance, 1966).

During the fermentation process, environment condition especially temperature should be well control to ensure yeast is work effectively. Yeasts begin their fermentation from 10°C and the rate is increased with the addition of temperature. At 21°C to27°C, yeasts reach optimum activity during the fermentation process. However, the continuously addition of the temperature will reduce the yeast activity. The yeasts are killed when the temperature reach 60°C (Hunter *et al.,* 2007). Also, the dough pH should be controlled in between pH 4 to pH 6. Once the pH is lower than the range; fermentation activity will be slowed down and affects the characteristics of the dough. In addition, amounts of yeast, salt and sugar should be added appropriately as they are the main characters in fermentation process. The changes can cause big influence to the final product (Suas, 2009).

Yeast is an essential ingredient in bread making process. During the fermentation process, the produced carbon dioxide does not leak out from the dough, but it is retained in the gluten network which aerates the dough. With the continuously production of carbon dioxide, more gas are trapped in the dough and this situation contribute to the expansion of dough. This process is very important in the formation of texture in the bread, which is highly distinguished from the unleavened bread (Stephenson, 2010). Aside from carbon dioxide, other byproducts such as ester,

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REFERENCES

Ajmal, M., Butt, M. S., Sharif, K., Nasir, M. and Nadeem, M. T. 2006. Preparation of fiber and mineral enriched pan bread by using defatted rice bran. *International Journal of Food Properties.* **9**: 623-636.

Angela, M. D. and Daniel, V. 1999. *Design and Analysis of Experiments.* New York: Springer-Verlag New York, Inc.

Anon. 1997a. Variety: Kennedy syn QT6063. Application no.96/209. *Plant Varieties Journal.* **10**: 50.

Anon. 1997b. Variety: Baxter syn QT625. Application no. 97/283. *Plant Varieties Journal.* **10**: 55-56.

Arendt, E. and Bell, F. D. 2008. *Gluten-Free Cereal Products and Beverages.* United States of America: Academic Press.

Ballard, D. 2009. *Master Bread Making Using Whole Wheat.* Springville: Cedar Fort, Inc.

Bambaradeniya, C. N. B andAmerasinghe, F, P. 2004. *Biodiversity Associated with Rice Field Agro-ecosystem in Asian Countries: A Brief Review.* Sri Lanka: International Water Management Institute.

Batres-Marquez, S. P., Jensen, H. H. and Upton, J. 2009. Rice consumption in the United States: Recent evidence from food consumption surveys. *Journal of American Dietetic Assiociation.***109**:1719-1727.

Belderok, B., Mesdag, J. and Donner, D. A. 2000. *Bread-Making Quality Of Wheat: A Century Of Breeding In Europe.* Netherland: Kluwer Academic Publishers.

UMS
UNIVERSITI MALAYSIA SABAH

Bouake and Coast, I. 1982. *An Overview Of Upland Rice Research*. Manila: International Rice Research Institute.

Brooker, B. E. 1996. The role of fat in the stabilization of gas cells in bread dough. *Cereal Science*. **24**(3):187-198.

Calvel, R., Wirtz, R. L. and MacGuire. J. J. 2001. *The Taste Of Bread*. Maryland: An Aspen Publication.

Carver, B. F. 2009. *Wheat: Science and Trade*. Iowa: Wiley-Blackwell.

Cauvain, S. P. 2003. *Bread Making: Improving Quality*. Cambridge: Woodhead Publishing Limited.

Cauvain, S. P. and Young, L. S. 2006. *Baked Products: Science, Technology and Practice*. Oxford: Blackwell Publishing Ltd.

Chinachoti, P. and Vodovotz, Y. 2000. *Bread Staling*. Boca Raton: CRC Press.

Dagoon, J. 2005. *Home Econimics Technology IV*. Quezon City: REX Printing Company.

Dewettinck, K., Van Bockstaele, F., Kuhne, B., Walle, V. D., Courtens, T. and Gellynck, X. 2008. Nutritional value of bread: influence of processing, food interaction and consumer perception. *Journal of Cereal Science*.**48**:243-257.

DiMuzio, D. T. 2010. *Bread Baking: An Artisan's Perspective*. New Jersey: John Wiley and Sons, Inc.

DOA. 2005. *Agriculture Statistical Handbook*. Ministry of Agriculture and Agro-based Industry.pp. 31.

UMS
UNIVERSITI MALAYSIA SABAH

Elleuch, M., Bedigian, D., Roiseux, O, Besbes, S., Becker, C. and Attia, h. 2011. Dietary fibre and fibre-rich by-products of food processing: Characterisation, technological functionality and commercial applications. *Food Chemistry*. **124**:411-421.

Fance, W. J. 1966. *The Student's Technology Of Breadmaking And Flour Confectionery*. New York: Routledge.

Fardet, A., Leenhardt, F., Lioger, D. Scalbert, A. and Remesy, C. 2006. Parameters controlling the glycaemic response to breads. *Nutrition Research Reviews*. **19**:18-25.

Figoni, P. 2008. *How Baking Works: Exploring The Fundamentals Of Baking Science*. New Jersey: John Wiley and Sons, Inc.

Fogiel, M. 2003. *The Chemstry Problem Solver*. New Jersey: Research and Education Association.

Food and Agricultural Organization of the United Nations (FAO). 1995. *Fruit and Vegetable Processing, Agricultural Services Bulletin No. 119*, http://www.fao.org/docrep/V5030E/V5030E0b.htm#5.2 Preservation by reduction of water. Retrieved 2 July 2012.

Food and Agriculture Organization of the United Nations (FAO). 2011. *Area Harvested of Rice, Paddy in Malaysia - 1961-2009;Production Quantity of Rice, Paddy in Malaysia-1961-2009*, http://faostat.fao.org/site/339/default.aspx. Retrieved 10 November 2011.

Food and Agriculture Organization of the United Nations (FAO). 2011. *Methods of Food Analysis*. http://www.fao.org/DOCREP/006/Y5022E/y5022e03.htm. Retrieved 10 November 2011.

UMS
UNIVERSITI MALAYSIA SABAH

Fortoul, R. A. and Rosell, C. M. 2010. Physico-chemical changes in breads from bake off technologies during storage. *Food Science and Technology.* **44**: 631-636.

Frei, M. and Becker, K. 2004. *On Rice, Biodiversity and Nutrients.* Stuttgart: Institute of Animal Production in Tropics and Subtropics.

Gallagher, E., Kunkel, A., Gormley, T. R. and Arendit, E. K. 2003. The effect of dairy and rice powder addition on loaf and characteristics, and on shelf life (intermediate and long-term) of gluten-free breads stored in a modified atmosphere. *European Food Research and Technology.* **218**: 44-48.

Giannou, V., Kessolou, V. and Tzia, C. 2003. Quality and safety characteristics of bread made from frozen dough. *Trends In Food Science and Technology.* **14**: 99-108.

Gomez, M., Ronda, F., Blanco, Caballero, P. and Apesteguia, A. 2003. Effect of dietary fibre on dough rheology and bread quality. *European Food Research and Technology.* **216**:51-56.

Gujral, H. S. and Rosell, C. M. (2004). Modification of the pasting properties of wheat starch by cyclodextrin glycosyltransferase. *Journal of the Science of Food and Agriculture.* **84**: 1685-1690.

Gujral, H. S., Haros, M. and Rosell., M. 2003. Starch hydrolyzing enzymes for retarding the staling of rice bread. *Cereal Chemistry.* **80**(6):750-754.

Gupta, P. C. and O'Toole, J. C. 1986.*Upland Rice: A Global Perspective.* Manila: International Rice Research Institute.

Hanafi, M. M., Hartinie, A., Shukor, J. and Mahmud, T. M. M. 2009. Upland rice varieties in Malaysia: Agronomic and soils physic-chemical characteristics. *Pertanika Journal Of Tropical Agricultural Science.***32**(2):225-246.

UMS
UNIVERSITI MALAYSIA SABAH

Hensperger, B. 2000. *The Bread Lover's Bread Machine Cookbook*. Boston: The Harvard Common Press.

Hitz, C. 2008. *Baking Artisan Bread: 10 Expert Formulas For Baking Batter Bread At Home*. Quarry.

Hui, Y. H. 2006. *Bakery Products: Science and Technology*. Iowa: Blackwell Publishing.

Hui, Y. H. and Corke, H. 2006. *Bakery Products: Science and Technology*. Iowa: Blackwell Publishing Professional.

Huke, R. E. and Huke, E. H. 1990. *Human geography of rice in Southeast Asia*. United States: International Rice Research Institute.

Hunter, G. Tinton, T. and Carey, P. 2007. *Professional Chef: Level 2*. London: Thomson Learning.

Idris, Z. 2005. *Manual Teknologi Penghasilan Produck Bakeri*. Serdang: Institut Penyelidikan dan Kemajuan Pertanian Malaysia (MARDI).

Isserliyska, D., Karadjov, G. and Angelov, A. 2001. Mineral composition of Bulgarian wheat bread. *European Food Research and Technology*. **213**(3):244-245.

John, S., Karthiga, S., Parimalam, S. R., Vasanthi, B. S. and Chellappa, A. R. 2004. *Nutrition And Dietetics*. Chennai: Tamilnadu Text Book Corporation.

Kadan, R. S., Robinson, M. G., Thibodeaux, D. P. and Pepperman JR, A. B. 2001. Properties of whole rice bread. *Journal of Food Science*. **66**(7): 940-944.

UMS
UNIVERSITI MALAYSIA SABAH

Kanchanapom, K. and Kanchanapom, M. 1998. Mangosteen. *In* Shaw, P. E., Chan, H. T. and Nagi, S. (eds). *Tropical and Subtropical Fruits*, pp. 191-216. United States: AgScience Inc.

Kastel, E. and Charles, C. 2010. *Artisan Breads At Home*. New Jersey: John Wiley and Sons, Inc.

Kensaku, O. 1991. Preparation and certification of rice flour-unpolished reference material. *The Science of The Total Environment*. **107**: 29-44.

Kent-Jones, D. W. and Amos, A. J. 1967. *Modern Cereal Chemistry*. London: Food Trade Press.

Kiple, K. F. and Ornelas, K. C. 2001. *The Cambridge World History Of Food*. Vol 2.United Kingdom: Cambridge University Press.

Kleinbaum, D. G., Kupper, L. L. and Muller, K. E. 2008. *Applied Regression Analysis And Other Multivariable Methods*. Belmont: Thomson Brooks/ Cole.

Legan, J. D. 1993. Mould spoilage of bread: the problem and some solutions. *International Biodeterioration and Biodegradation*. **32**: 33-53.

Marerat, M., Powan, P. and Singthong, J. 2011. Functional properties of rice bran and its application in bread. Bangkok: 12th Asean Food Conference 2011.

Megat Rusydi, M. R., Noraliza, C. W., Azrina, A. and Zulkhairi, A. 2011. Nutritional changes in germinated legumes and rice varieties. *International Food Research Journal*. **18**: 705-713.

Meilgaard, M. C., Civille, G. V. and Carr, B. T. 2007. *Sensory Evaluation Techniques* (4th edition). Boca Raton: Taylor and Francis Group, LLC.

UMS
UNIVERSITI MALAYSIA SABAH

Ministry Of Health Malaysia (MOH). 2006. *Guide To Nutrition Labelling And Claims.* Kuala Lumpur: Food Safety and Quality Division.

Mohamad, A., Wahab, A. and Durrani, Y. 2003. Effect of water activity (A_W) moisture content and total microbial count on the overall quality of bread. *International Journal Of Agriculture and Biology.* **5**(3): 274-278.

Mohamad, B. O. and Abdul Rahman, M. 2006. *Fruits For The Future 9: MangosteenGarciniaMangostana.* England: RPM.

Mondal, A. and Datta, A. K. 2008. Bread baking: A review. *Journal of Food Engineering.* **86**:465-474.

Murano, P. S. 2003. *Understanding Food Science and Technology.* United States: Wadswoth/ Thomson Learning, Inc.

Muthuna, D. O. and Larimore, W. 2006.*Alternative Medicine.* Michigan: Zondervan.

Ndife, J., Abdulraheem, L. O. and Zakari, U. M. 2011. Evaluation of the nutritional and sensory quality of functional breads produced from whole wheat and soya bean flour blends. *African Journal of Food Science.* **5**(8): 466-472.

Neusner, J. 1999. *Scripture and The Geberative Premises of The Halakhah: Vol 3 Scripture's Topics Independently Developed In The Halakha: From The Babas Through Miqvaot.* New York: Global Publications, ICGS.

Nielsen, S. S. 2003. *Food Analysis* (3rd edition). New York: Kluwer Academic/ Plenum Publishers.

Norimah, A. K., Safiah, M., Jamal, K., SitiHaslinda, Zuhaida, H., Rohida, S., Fatimah, S., SitiNorazlin, Poh, B. K., Kandiah, M., Zalilah, M. S., Wan Manan, W. M., Fatimah, S.andAzmi, M. Y. 2008. Food consumption patterns: Findings from

UMS
UNIVERSITI MALAYSIA SABAH

the Malaysian Adult Nutrition Survey(MANS). *Malaysian Journal of Nutrition.* **14**(1):25.

Nursten, H. E. 2005. *The Maillard Reaction: Chemistry, Biochemistry, and Implications.* Great Britain: RSC Publishing.

Parker, R. 2003. *Introduction To Food Science.* New York: Delmar/ Thomson Learning, Inc.

Pennington, N. L. and Baker, C. W. 1990. *Sugar, A User's Guide To Sucrose.* New York: Van Nostrand Reinhold.

Ploetz, R. C. 2003. *Diseases of Tropical Fruit Crops.* Trowbridge: Cromwell Press.

Pradeepkumar, T., Jyothibhaskar, B. S. and Satheesan, K. N. 2008.*Horticulture Science Series: Management of Horticultural Crops.* Volume 11. New Delhi: New India Publishing Agency.

Radha, T. and Mathew, L. 2007.*Fruit Crops: Vol 03 Horticultural Science Series.* New Delhi: New India Publishing Agency.

Rajan, S. and Markosa, B. L. 2007.*Propagation Of Horticultural Crops: Vol 06 Horticultural Science Series.* New Delhi: New India Publishing Agency.

Rakkar, P. S. 2007. *Development Of A Gluten-Free Commercial Bread.* Auckland: Auckland University of Technology.

Roach, R. R and Hoseney, R. C. 1995. Effects of certain surfactants on the starch in bread. *Cereal Chemistry.* **72**(6):578-582.

Rochelle, J. C. 2001. *Bread for Wilderness: Baking As Spiritual Craft.* United States: Xulon Press.

UMS
UNIVERSITI MALAYSIA SABAH

Rosentrater, K. A. 2011. *Distillers Grains, Production Properties, and Utilization.* United States: AOCS Publishing.

Sabanis, D. and Tzia, C. 2007. Effect of rice, corn and soy flour addition on characteristics of bread produced from different wheat cultivars. *Food Bioprocess Technology.* **2**: 68-79.

Saddozail. A. A. and Khalil, S. 2009. Microbiological Status of Bakery Products Available In Islamabad. *Pakistan Journal of Agricultural Research.* **22**: 93-96.

Schiller, J. M., Chanphengxay, M. B., Linquist, B. and AppaRao, S. 2006. *Rice in Loas.* Manila: International Rice Research Institute.

Sharif, M. K., Butt, M. S. Anjum, F. M. and Nawaz, H. 2009. Preparation of fiber and mineral enriched defatted rice bran supplemented cookies. *Pakistan Journal of Nutrition.* **8**(5): 571-577.

Smith. J. S. and Hui, Y. H. 2004. *Food Processing: Principles and Applications.* Iowa: Blackwell Publishing.

Sompong, R. Siebenhandl-Ehn, S., Linsbenger-Martin, G and Berghofer, E. 2011. Physicochemical and antioxidative properties of red and black varieties from Thailand, China and Sri Lanka. *Food Chemistry.* **124**(1):132-140.

Stanley, P., Cauvin, P. and Young, L. S. 2007. *Technology of Breadmaking.* New York: Springer Science and Business Media, LLC.

Stephenson, S. L. 2010. *The Kingdom Fungi: The Biolgy of Mushrooms, Molds, And Lichens.* Oregon: Timber Press, Inc.

Street, C. A. 1991. *Flour Confectionery Manfacture.* New York: VCH Publishers, inc.

UMS
UNIVERSITI MALAYSIA SABAH

Sumnu, S. G. and Sahin, S. 2008. Food Engineering Aspects of Baking Sweet Goods. Boca Raton: CRC Press.

Suas, M. 2009. *Advanced Bread and Pastry: A Professional Approach.* New York: Delmar Cengage Learning.

United States Department of Agricultural (USDA). 2008. *Commercial Item Description-Flour,* http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELDEV3006569. Retrieved 2 July 2012.

Velluppillai, S., Nithyanantharajah, K., Vasantharuba, S., Balakumar, S. and Arasaratnam, V. 2010. Optimization of bread preparation from wheat flour and malted rice flour. *Rice Science.* **17**(1):51-59.

Wilson, T. A., Ausman, L. M., Lawton, C. W., Hegsted, D. M. and Nicolosi, R. J. 2000. Comparative cholesterol lowering properties of vegetables oils: beyond fatty acids. *Journal Of American College Of Nutrition.* **19**(5): 601-607.

Wiley, L. 2007. *Kirk-Othmer Food and Feed Tecnology.* New York: John Wiley and Sons, Inc.

Yaacob, O. and Tindall, H. D. 1995. *Mangosteen Cultivation.*Rome: Food and Agriculture Organization.

Yodmanee, S., Karrila, T. T. and Pakdeechanuan, P. 2011. Physical, chemical and oxidant properties of pigmented rice grown in Southern Thailand. *International Food Research Journal.* **18**(3):901-906.

Yousef, A. E. and Carlstrom, C. 2003. *Food Microbiology: A Laboratory Manual.* New York: Wilwy-IEEE.

UMS
UNIVERSITI MALAYSIA SABAH

Zhou, Z., Blanchard, C., Hellwell, S. and Robards, K. 2003. Fatty acid composition of three rice varieties following storage. *Journal Of Cereal Science*. **37**(3): 327-335.

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UNIVERSITI MALAYSIA SABAH