NUTRTIONAL QUALITY OF FERMENTED SPRAY DRIED *MEDIDA* FORMULATED FROM MALTED BROWN RICE WITH *Bifidobacterium longum* BB 536

By

BARKA MOHAMMED KABEIR BARKA

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Science

May 2004

DEDICATION

TO MY PARENTS, MY BROTHERS AND SISTERS

TO ELDEST BROTHER EZAL DEEN FOR HIS UNLIMITED SUPPORT

WITH LOVE AND GRATITUDE

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Master of Science

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Chairman : Professor Dr. Mohd. Yazid Abd Manap, Ph.D.

Faculty : Food Science and Technology

The processing technique of *medida*, the traditional Sudanese porridge was modified to improve the nutritional quality. The paddy rice was steeped and malted at 30 ˚C. *Medida* was formulated using 225 g brown rice flour of two days malted paddy with added skim milk at 2.25 %, 4.5% and 10% levels (W/ V) were studied. The initial pH was 6.7 and fermentation was run to a final pH of 4.4 using culture of *Bifidobacterium longum* BB 536. Fermented *Medida* containing *B. longum* BB 536 cell counts up 9 Log CFU/ ml was spray dried at different heat adaptations and spray drying air outlet temperatures with fixed inlet temperature of 160 ˚C.

Two days malted rice flour had the highest protein (9.16 ± 0.16 %) and lysine (7.70 ± 0.10 %) content, in addition to the significant ($P < 0.01$) increase in glucose (8.67 ± 0.07) due to the activity of alpha amylase enzyme. The total solid

of the malted brown flour was high, 3.4 folds at the similar viscosity of the brown flour.

During fermentation of *medida* the highest count of 9.82 ± 0.18 log CFU *B. longum* BB 536/ ml was obtained with 10 % of added skim milk. At this level, the final concentrations of lactic and acetic acids were 57.76 ± 0.78 and 6.07 ± 0.15 µmol / ml, respectively. The relative ratio of acetic acid to lactic acid decreased as fermentation continues due to the higher rate of lactic acid production. Under refrigerated storage the count of *B. longum* BB 536 remained relatively stable during the first week (9.7 ± 0.1log CFU / ml), then decreased by 0.9 log CFU / ml in the second week.

At stable flowing characteristics and a similar viscosity of spontaneously fermented brown rice *medida*, there was 12 folds increase in total solids, the protein and energy density were significantly ($P< 0.01$) improved. The essential amino acids including lysine and methionine were highly augmented.

The survival of *B. longum* BB 536 during the spray drying of the fermented *medida* decreased with elevation of outlet temperature, but increased dependent on heat adaptation temperature prior to the spray drying. At adaptation temperature of 45 ˚C for 25 min, there was a significant improve in viability retention at 85 – 88 ˚C outlet temperature, and spray dried *medida* with 7.81 ± 0.1 Log CFU *B. longum* BB 536/ g was obtained. Under refrigerated storage the

viable count of the strain (7.81 ± 0.1 Log CFU / g) remained stable for 11 days, and then decreased by 0.77 log CFU/ g in 70 days.

Compared with commercial cereal based food, the nutritional composition of the spray dried fermented *medida* is better. Referring to the recommended dietary allowance for 1- 12 years old, 475 g spray dried *medida* provides more than the sufficient protein (92 g) and energy (1767 kcal) requirements. The same amount provides the whole needs from calcium (642 mg) and the essential amino acids as follow: 1232 mg lysine, 2028 mg valine, 874 mg isoleucine, 1206 mg lucine, and 796 mg thronine.

In conclusion, two days malted brown rice flour is nutritionally superior in the protein and the limiting amino acid lysine with having higher total solids. Moreover, the fermented *medida* from malted rice is a suitable food system for the delivery of *B. longum* BB 536. The addition of 10% skim improved the growth of *B. longum* BB 536 and the quality of *medida* from malted rice. The heat adaptation prior to the spray drying potentially improved the survival of *B. longum* BB 536, and the viable count attained in the final powder met the number required to presence in the probiotic bifidus product. Hence, the spray dried *medida* from malted brown rice is of dietetic-therapeutic benefit.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Sarjana Sains

NUTRISI KUALITI MAKANAN FERMENTASI SEMBURAN KERING *MEDIDA* YANG DIFORMULASI DARIPADA TEPUNG BERAS PERANG DICAMPUR MALT DERGAN *Bifidobacterium longum* BB 536

Oleh

BARKA MOHAMED KABEIR

Mei 2004

Pengerusi : Profesor Dr. Mohd. Yazid b. Abd. Manap, Ph.D.

Fakulti : Sains Makanan dan Teknologi

Teknik pemprosesan Medida, sejenis bubur berkaleng tradisional dari Sudan telah diubahsuai bagi meningkatkan lagi nutrisi kualitinya. Beras direndam dan dicampur malt pada 30 ˚C. *Medida* diformulasi menggunakan 225 g tepung beras perang yang dicampur malt selama dua hari. Kesan pertambahan susu skim sebanyak 2.25 %, 4.5 % dan 10 % dikaji. pH permulaan adalah 6.7 dan fermentasi dijalankan sehingga pH terakhir 4.4 menggunakan kultur *Bifidobacterium longum* BB 536. Tepung beras perang dicampur malt berfermentasi yang mengandungi *B. longum* BB 536 sehingga 9 log CFU/ ml telah disembur kering berdasarkan adaptasi haba dan suhu luaran penyemburan kering yang berbeza dengan suhu dalaman yang tetap sebanyak 160 ºC.

Tepung beras perang dicampur malt dalam tempoh 2 hari mengandungi kandungan protein (9.16 ± 0.16 %) dan lysine (7.70 ± 0.10 %) yang tertinggi. Kandungan glukosa beras perang dicampur malt meningkat secara signifikan ($P < 0.01$) disebabkan aktiviti enzim alpha amylase. Pada kelekitan yang sama bagi tepung beras perang tidak dicampur malt, beras perang yang dicampur malt dalam tempoh dua hari mempunyai 3.4 peningkatan tertutup dalam jumlah pepejal.

Semasa fermentasi *medida*, pengiraan tertinggi sebanyak 9.82 ± 0.18 log CFU/ml didapati dengan pertambahan 10 % susu skim dimana, kepekatan asid laktik dan asetik masng-masing adalah 57.76 ± 0.78 dan 6.07 ± 0.15 μmol/ml. Nisbah relatif antara asid laktik kepada asid asetik mengurang semasa fermentasi dijalankan disebabkan peningkatan penghasilan laktat. Di bawah penyimpanan sejuk, pengiraan bagi *Bifidobacterium longum* BB 536 dalam *medida* yang difermentasi adalah stabil secara relatifnya semasa minggu pertama (9.7 ± 0.1 log CFU/ ml), kemudian mengurang sebanyak 0.9 log CFU/ ml dalam minggu kedua.

Pada kelekitan yang sama medida yang difermentasi spontan dengan tepung beras perang tidak dicampur malt bersama ciri pengaliran stabil, terdapat 12 peningkatan tertutup dalam jumlah pepejal, protein dan tenaga meningkat secara signifikan ($P < 0.01$). Asid amino lysine dan metionin yang diperlukan juga meningkat dengan banyak sekali.

Berdasarkan adaptasi haba (45ºC untuk 25 minit) terutamanya untuk semburan kering, terdapat peningkatan secara signifikan ($P < 0.05$) dalam kebolehan bermandirian pada 85-88ºC suhu luaran, dan pengiraan sebanyak 7.81 ± 0.1 log CFU *B. longum* BB 536/ g diperolehi. Dibawah peryimpanan sejuk, pengiraan CFU (7.81 ± 0.1 log CFU/ g) adalah stabil selama 11 hari, dan diikuti pengurangan dengan sebanyak 0.77 log CFU/ g dalam 70 hari.

Perbandingan dengan makanan berasaskan bijirin yang komersil, nilai nutrisi medida daripada tepung beras perang difermentasi dan disembur kering adalah lebih baik. Berdasarkan nutrisi dan tenaga harian yang diperluuan oleh bayi dan kanak-kanak 1- 10 tahun, 475 g semburan kering *medida* memenuhi lebih daripada keperluan protein (92 g) dan tenaga (1767 kcal) harian. Disamping itu, ia juga memenuhi keperluan kalsium (642 mg), lysine (1232 mg), valine (2028 mg), isoleucine (874 mg), leucine (1206 mg) dan thronine (796 mg).

Kesimpulannya, tepung beras perang yang dicampur malt selama dua hari adalah lebih tinggi nutrisi bagi protein dan amino asid lysine dengan jumlah pepejal yang lebih tinggi. Maka medida difermentasi dairpada tepung beras pering dicampur malt adalah system pemakanan yang sesuai untuk menyalurkan *B. longum* BB 536 kepada pengguna. Penambahan susu skim 10% meningkatkan pengiraan CFU *B. longum* BB 536 dan kualiti *medida.* Adaptasi haba sebelum semburan kering meningkatkan keupayaan untuk hidup *B. longum* BB 536. *Medida* yang terbaik mengondungi *B. longum* BB 536 hidup dan

memenuhi peratus yang diperlukan dalam produk bifidus probiotics. Maka, medida adalah manfaat terapeutik – dietetik.

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I certify that an Examination Committee met on 4th November 2004 to conduct the final examination of Barka Mohammed Kabeir Barka on his Master of Science thesis entitled ˜**NUTRTIONAL QUALITY OF FERMENTED SPRAY DRIED *MEDIDA* FORMULATED FROM MALTED BROWN RICE WITH *Bifidobacterium longum* BB 536**" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination committee are as follows:

Salmah Yusof, Ph.D.
Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Chairman)

Abdul Jalil Kader, Ph.D.
Professor
Faculty of Science and Technology
Universiti Kebangsaan Malaysia
(External Examiner)

Arbakariya Ariff, Ph.D.
Professor
Faculty of Biotechnology and Bimolecular Science
Universiti Putra Malaysia
(Independent Examiner)

Zaiton Hassan, Ph.D.
Associate Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Independent Examiner)

_____

GULAM RUSUL RAHMAT ALI, Ph.D.
Professor/Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia
Date:

This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfillment of the requirements for the degree of Master of Science. The members of Supervisory Committee are as follows:

Mohd Yazid Abd Manap, Ph.D.
Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Chairman)

Suraini Abd Aziz, Ph.D.
Associate Professor
Faculty of Biotechnology and Bimolecular Science
Universiti Putra Malaysia
(Member)

Sharifah Kharidah Syed Muhammad, Ph.D.
Associate Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Member)

_____
AINI IDERIS, Ph.D.
Professor/Dean
School of Graduate studies
Universiti Putra Malaysia

Date:

DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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BARKA MOHAMMED KABEIR
Date:

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