UNIVERSITI PUTRA MALAYSIA

NUTRITIONAL QUALITY OF GERMINATED COWPEA FLOUR AND ITS APPLICATION IN HOME PREPARED INSTANT WEANING FOOD

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1998

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By

JIRAPA PONGJANTA

Thesis Submitted in Fulfillment of the Requirements for
the Degree of Master of Science in the Faculty
of Medical and Health Science
Universiti Putra Malaysia

October 1998

Dedicated to my beloved mother, Pimpa Pongjanta, for her moral support and encouragement during my study in Malaysia.

ACKNOWLEDGEMENTS

I would like to express my special appreciation and sincere gratitude to my committee members, Ms. Normah Hashim, Dr. Sharifah Kharidah Syed Muhammad, Ms. Zamaliah Mohd Marjan, and Dr. Asmah Rahmat for their understanding, valuable guidance and advice throughout this study and in the preparation of this thesis.

I wish to thank the Dean, Head, and all the members of the Department of Nutrition and Community Health, Faculty of Medical and Health Science, UPM for providing facilities and technical assistance during the course of my study. My appreciation and sincere gratitude is extended to Lampang Agricultural Research and Training Centre, Rajamangala Institute of Technology, Ministry of Education, Thailand in allowing me to pursue my Master of Science degree at UPM.

Appreciation is extended to Dr. Tee E Siong, the Head of the Division, and Ms. Khor Swan Choo, a Senior Medical Laboratory Technologist for Human Nutrition of the Institute for Medical Research Kuala Lumpur, Malaysia for their valuable guidance, assistance, and provisioning the facilities for vitamin A analysis. I would also like to thank all my friends for their help a great deal of encouragement to initiate and complete the study.

Finally, I wish to express my deepest gratitude to my beloved mother Pimpa Pongjanta, my brothers, sisters and nephews who have given me moral support and encouragement during my study in Malaysia.

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LIST OF ABBREVIATIONS

AAS	- Amino Acid Score
AOAC	- Association of the Official Analytical Chemists
ANOVA	- Analysis of Variance
ArAA	- Aromatic Amino Acid (Phenylalanine plus tyrosine)
Arg	- Arginine
Ala	- Alanine
Asp	- Aspartic acid
BP	- Banana and Pumpkin
CBV	- Calculated Biological Value
CCF	- Controlled-Cowpea Flour
CRD	- Completely Randomised Design
DMRT	- Duncan's Multiple Range Test
EAAI	- Essential Amino Acid Index
EAAS	- Essential Amino Acid Score
FAO	- Food Agricultural Organisation
GCF	- Germinated-Cowpea Flour
Glu	- Glutamine
Gly	- Glycine
His	- Histidine
Iso	- Isoleucine

IVPD	- *In vitro* Protein Digestibility
IVSD	- *In vitro* Starch Digestibility
Leu	- Leucine
Lys	- Lysine
NRC	- National Research Council
PDCAAS	- Protein Digestibility Corrected Amino Acid Score
Ser	- Serine
SAA	- Sulphur Amino Acid (methionine plus cysteine)
SAS	- Statistical Analysis System
SMP	-Skim Milk Powder
Trp	- Tryptophan
Val	- Valine
WHO	- World Health Organisation
Kg	- Kilogram (s)
g	- Gram(s)
mg	- Milligram (s)
μg	- Microgram (s)
L	- Litres (s)
ml	- Millilitre (s)

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

NUTRITIONAL QUALITY OF GERMINATED-COWPEA FLOUR AND ITS APPLICATION IN HOME PREPARED INSTANT WEANING FOOD

By

JIRAPA PONGJANTA

OCTOBER, 1998

Chairman : Ms. Normah Hashim

Faculty : Medical and Health Science

The *in vitro* protein quality, starch digestibility and vitamin A content of weaning food raw materials consist of rice, controlled-cowpea flour (CCF), 24h germinated- cowpea flour (24h GCF), 48h germinated-cowpea flour (48h GCF), skim milk powder and banana-pumpkin, were studied. CCF or GCF was formed to be protein rich food and banana-pumpkin was used to supplement vitamin A in the weaning food. Cowpea seeds were germinated (24h, and 48h at 25°C), dried (60-75°C for 12 hours) and ground to form a powder. The physiochemical properties, amino acid profile, and protein quality comprise of protein digestibility corrected amino acid scores (PDCAAS), chemical score, amino acid score (AAS), essential amino index (EAAI), calculated biological value (C-BV) and FAO Score (FAOS) of treated cowpea flour were analysed. *In vitro* method with commercial digestive enzymes was used in assessing the protein and starch digestibility of CCF, 24h GCF and 48h GCF.

Results of the study showed that germinated-cowpea were found to be reduced in the total soluble solid. There was also no noticeable change were observed in the pH, and total acidity from cowpea seeds. The hypocotyl length of sprouts increased upon 24h and 48h germination. There were no significant difference in the moisture and protein contents between CCF, 24h GCF and 48h GCF. Fat, ash, and nitrogen free extract were found to be the highest in CCF while, crude fiber was found to be the highest in 48h GCF. Findings of study revealed that 24h GCF and 48h GCF significantly enhances the *in vitro* protein digestibility (IVPD). Germination had little effect on amino acid profile of cowpea. The CCF had a higher in total amino acid than GCF, but lowest in IVPD. The *in vitro* protein digestibility corrected amino acid scores, chemical score, amino acid score, and FAO scores were found to be highest in 48h GCF. Both scores show sulphur amino acids were calculated to be the first limiting amino acid and leucine as the second in CCF and GCF. *In vitro* starch digestibility was also significantly higher with GCF. The CCF and GCF were lowest in vitamin A composition. While, banana-pumpkin blended contains high concentration of provitamin A carotenoids. Skim milk powder is a source of retinol content.

A composite of 35% rice flour, 35% of CCF, 24h GCF or 48h GCF, 15% banana-pumpkin, 15% skim milk powder and 5% sugar were used as the weaning food raw material. An oven – drying method was employed in the production of the weaning food. It was found that protein, ash, fat, crude fiber and calories content of the weaning food samples were within the range prescribed by International Standard for Weaning Food (1997). The CCF weaning food has a low protein digestibility but

high in amino acid stability, while, 24h GCF and 48h GCF weaning food improved the *in vitro* protein digestibility of weaning foods. Based on the amino acid requirement for 0 to 12 months old infant, the PDCAAS of 24h GCF weaning food was higher (55.49 %), than CCF weaning food (46.74%). Tryptophan was calculated to be the first limiting amino acid and histidine was to be the second limiting amino acid. The EAAI, EAAS and C-BV of CCF weaning foods were highest. Total retinol equivalent was found to be fairly stable after oven drying processed. *In vitro* starch digestibility of 48h GCF weaning food was higher than that of the CCF and 24h GCF weaning foods. The 24h GCF and 48h GCF weaning food had the lowest water absorption index and bulk density. The 24h GCF weaning food was acceptable to the panellist with a high score (7.30) for overall acceptability.

Thus, it can be concluded that the addition of germinated cowpea flour to weaning food improved its protein and starch digestibility and the weaning food was acceptable in term of physiochemical, and organoleptic qualities. The 24h GCF weaning food was suitable for household consumption and can be a good substitute for commercial formula.

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

KUALITI PEMAKANAN TEPUNG KACANG POL BERCAMBAH, DAN APLIKASINYA DI DALAM MAKANAN CERAI SUSU

Oleh

JIRAPA PONGJANTA

OKTOBER, 1998

Pengerusi : Normah Hashim

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Projek ini mengkaji kualiti protein *in-vitro*, penghadaman kanji, dan aktiviti vitamin A bagi bahan mentah makanan cerai susu (tepung kacang pol, tepung kacang pol selepas 24 jam dan 48 jam percambahan, susu tepung skim, dan campuran pisang dan labu). Tepung kacang pol (controlled-cowpea flour; CCF), dan tepung kacang pol bercambah (germinated-cowpea flour; GCF) merupakan makanan yang tinggi protein dan pisang-labu (banana-pumpkin;B-P) merupakan makanan komplementari sumber vitamin A bagi makanan cerai susu. Biji kacang pol dicambahkan selama 24 jam dan 48 jam pada suhu 25°C, kemudian dikeringkan pada suhu 60-75°C selama 12 jam dan dikisar menjadi tepung. Ciri-ciri fisio-kimia, profil asid amino, dan protein digestibility corrected amino acid score (PDCAAS), skor asid amino (AAS), indeks asid amino perlu (EAAI), nilai biologi (C- BV), dan skor FAO (FAOS) sebagai perlakuan terhadap kacang pol telah dikaji. Kajian *in- vitro* dengan menggunakan enzim-enzim penghadaman komersial dilakukan untuk menilai tahap penghadaman protein dan kanji bagi CCF, GCF 24 jam, dan GCF 48 jam.

Keputusan yang didapati menunjukkan "GCF" mengurangkan jumlah pepejal larut, tetapi tidak terdapat perubahan dari segi pH, serta asiditi. Terdapat peningkatan panjang hipokotil tunas bagi percambahan 24 jam dan 48 jam. Tidak ada perbezaan yang signifikan dalam lembapan, dan protein di antara CCF dan GCF. Lemak, abu, dan ekstrak bebas nitrogen didapati tinggi dalam CCF. Serat didapati tertinggi kandungannya dalam GCF 48 jam. Kajian ini membuktikan bahawa GCF 24 jam, dan GCF 48 jam meningkatkan penghadaman protein *in-vitro* (*in -vitro* protein digestibility ; IVPD). Percambahan mempunyai kesan yang sedikit terhadap profil asid amino kacang pol. CCF mempunyai profil asid amino yang lebih tinggi daripada GCF, tetapi paling rendah dalam IVPD. PDCAAS didapati tertinggi dalam GCF 48-jam. Manakala AAS, EAAI, C-BV, dan FAOS didapati tertinggi dalam CCF. Kedua - dua skor menunjukkan asid amino sulfur (metionina dan sistein) merupakan asid amino terhad yang utama dan leusina merupakan yang kedua terbanyak dalam CCF dan GCF. Penghadaman kanji *in- vitro* juga didapati meningkat dengan GCF. Sebatian pisang - labu mengandungi provitamin A (karotenoid) yang tinggi tetapi aktiviti vitamin A (μg RE), yang sederhana berbanding retinol equivalent (RE). Susu tepung skim pula merupakan sumber yang kaya dengan kandungan retinol.

Gabugan 35% tepung beras kepada 35% CCF atau GCF 24 jam atau, GCF 48 jam, 15% pisang - labu, 15% susu tepung skim, dan 5% gula digunakan sebagai bahan mentah makanan cerai susu. Kacdah pengeringan oven digunakan untuk penghasilan makanan cerai susu. Kajian mendapati kandungan protein, abu, lemak, fiber kasar dan kalori terletak dalam julat yang disyorkan oleh Piawai

Antarabangsa (1997) untuk makanan cerai susu. Didapati proses makanan cerai susu CCF mengakibatkan penurunan penghadaman protein, tetapi terdapat peningkatan kestabilan asid amino. Sementara GCF 24 jam atau 48 jam meningkatkan penghadaman protein *in vitro* bagi makanan cerai susu. Berdasarkan keperluan asid amino untuk bayi berumur 0-12 bulan, keputusan ke atas skor PDCAAS bagi makanan cerai susu GCF 24 jam, adalah lebih tinggi (55.49%) daripada makanan cerai susu CCF sahaja (46.74%). Didapati triptofan adalah asid amino pertama yang terhad diikuti oleh histidina. Nilai EAAI, EAAS dan C-BV tepung kacang pol (CCF) adalah lebih tinggi daripada kacang yang dicambah. Kandungan retinol equivalent didapati stabil selepas pemprosesan pengeringan oven makanan cerai susu. Penghadaman kanji secara *in vitro* oleh GCF 48 jam adalah lebih tinggi dari pada penghadaman kanji dalam CCF dan GCF 24 jam pada makanan cerai susu. Parameter fizikal makanan cerai susu dari GCF 48 jam adalah paling rendah dari segi indeks penyerapar air, dan ketumpatan bulk. Makanan cerai susu dari GCF 24 jam dapat diterima selepas dimakan oleh ahli panel sensori dengan mencapai markah 7.3 bagi skor penerimaan keseluruhan.

Kesimpulannya makanan cerai susu yang ditambah dengan tepung kacang pol cambah, meningkatkan penghadaman protein dan kanji, dan dapat diterima dengan memuaskan oleh ahli panel untuk penerimaan secara keseluruhan. Tepung kacang pol cambah (GCF) 24 jam sesuai digunakan dalam makanan cerai susu untuk penyediaan di rumah dan boleh menjadi gantian kepada makanan cerai susu komersial.

CHAPTER I

GENERAL INTRODUCTION

Weaning foods constitute an important category of fabricated foods, which are rapidly increasing in consumer acceptance. The consumption of commercial weaning food preparation has increased considerably during the last 20 years, although large variations are observed in different countries. The market for weaning food valued at $968.9m in 1995 after growth of 1.5 per cents. Projected revenues in 1996 are expected to reach $979.3m having risen by 1.1 per cent, with constant growth of one per cent in 1997 and 1998 (Frost and Sllivan, 1998).

Weaning foods are used during the transitional period, which started with complementing breast-feeding until the child receives a full diet. Breast milk is adequate to meet energy and nutrient requirements of an infant up to the first six months of age. Thereafter, breast milk is insufficient to sustain normal growth of an infant and need to be supplemented with other foods. Malnutrition among children is widespread in most developing countries and the condition is particularly serious in children below three years of age (Brown and Solomons, 1991). As the importance of preventing malnutrition is now well recognised, there is a need for nutritionally balanced, energy dense and easily digestible weaning foods (Weaver, 1994).

Numerous studies have been carried out on the available protein, energy, vitamin, and mineral composition of weaning foods. Anon (1991) and Nout (1993) reported that germination of cereals and legumes were used to increase the energy density and protein availability of weaning foods. Incorporation of legumes into cereal based weaning food will increase the nutrient composition of weaning foods. As in other legumes, proteins in cowpea are rich in glutamic acid, aspartic acid, and lysine but low in sulphur amino acids (Aremu, 1990). Methionine is the first limiting amino acid in cowpea protein (Kochhar et al., 1986). The high lysine content (6.86 mg/g) makes cowpea an excellent source to enhance protein quality when combined with cereal grain proteins, which are low in lysine but rich in sulphur amino acids such as rice. This might be an enhancement of amino acid balance achieved by the mixture of cowpea and rice protein. Beside the limiting amino acids, legumes contain protease inhibitors such as trypsin inhibitor that are responsible for reducing the digestibility of protein by inhibiting protease activity (Witoon et al., 1996). This statement is hanging on its own Obizoba (1989) suggested that the joint action of germination and cooking improved the nutritional quality of a cowpea - rice flour mixture.

Young children who are deficient in vitamin A seem more susceptible to severe infections, particularly dehydrating diarrhoea, and pneumonia. The less effective epithelial barriers may explain this susceptibility to infection in vitamin A deficiency and to a reduction in immune function (Philip et al., 1994).

Improving the vitamin A status of children is therefore particularly important, for the welfare of children. Thus a local source of vegetable rich in β-carotene such as pumpkin and banana should be used to increase the vitamin A content of locally prepared weaning foods. Thus, the major objective of this study was to produce a safe nutritious and tasty instant weaning food with germinated cowpea flour, banana and pumpkin, which can be home processed. The specific objectives of this thesis, however, are as follows:

(i) To determine the effect of cowpea germination on physiochemical properties, amino acid profile, *in vitro* protein quality, starch digestibility and vitamin A content of cowpea flour.

(ii) To formulate home prepared powdered weaning foods using germinated cowpea flour, pumpkin and banana

(iii) To determine the physiochemical properties, amino acid profile, *in vitro* protein quality, starch digestibility and vitamin A content of the formulated weaning foods.

(iv) To determine the organoleptic acceptance of the formulated weaning foods by sensory evaluation.