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Proximate Composition and Effect of Processing on Protein Quality of Minor Cereals Grown in Sri Lanka

By

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Declaration

The work describe in this thesis was carried out by me under the supervision of Mrs.D.Rajapaksha,Dr.Sagarika Ekanayake and Dr.K.K.D.S.Ranaweera and a report on this thesis has not been submitted in whole or in part of any University or any other institution for another degree.

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Proximate Composition and Effect of Processing on Protein Quality of Minor Cereals Grown in Sri Lanka

ABSTRACT

Kurakkan (*Eleucine coracana*), *Meneri* (*Panicum missiaceum*), Sorghum (*Sorghum vulgare*) and *Thanahal* (*Setaria italica*) are underutilized minor cereals in Sri Lanka. These varieties are recommended to be grown in Sri Lanka by Field Crop Research Development Institute at *Mahaillupallama* as a source of energy and protein. This study was undertaken in order to determine the chemical composition , the effect of processing on Protein Efficiency Ratio and antinutrients of of *Kurakkan (Ravi), Meneri* (AC254), Sorghum (ICSR 94002) and *Thanahal* (935).

Chemical analysis and determination of Protein Efficiency Ratio (rat bioassay) of minor cereals were carried out according to the AOAC official methods. Carbohydrate levels of minor cereals varied from 71.00-80.52g/100g and crude fiber level of minor cereals ranged from 0.52-2.54 g/100g. Low levels of fat (1.47, 1.91g/100g) were seen in *kurakkan* and *meneri* while high levels of fat (2.76, 4.6g/100g) were seen in sorghum and *thanahal* respectively. Protein contents were 7.7, 12.8, 7.8 and 13.8g/100g in *Kurakkan, Meneri*, Sorghum and *Thanahal* respectively. The average weight gain of rats were significantly lower than in the group fed the reference diet ($p \leq 0.05$) and the estimated Protein Efficiency Ratios of raw *Kurakkan, Meneri* , Sorghum and *Thanahal* were 0.24±0.09, 0.15±0.03, 0.50±0.33 and 0.20±0.09 respectively which were significantly lower than the reference casein ($p \leq 0.05$). In steamed cereals the values were 0.26±0.07, 0.17±0.06, 0.54±0.21 and 0.21±0.09 with no significant($p \geq 0.05$) different from rawrespectively. The phytate amounts of raw and steamed *Kurakkan, Meneri*, Sorghum and *Thanahal* were 1.45, 0.76, 1.28 0.67mg/100g and 1.44, 0.78, 1.31 and 0.70mg/100g respectively. The phytate amounts were significantly ($p \leq 0.05$) reduced by soaking and cooking and values were 0.92, 0.70, 1.07 and 0.52mg/100g respectively.

The results confirmed low protein digestibility and bioavailability of raw and steamed cereals and indicated that protein quality is not improved by steaming only. It is expected that soaking and cooking will increase the protein quality because according to above results the phytate amount of thus processed cereals were reduced.

Chapter 01

INTRODUCTION

1.1 Introduction

Sri Lanka is blessed with a wide variety of cereals, legumes, fruits and vegetables which can be successfully utilized in the formulation of foods. Minor cereals are main staples of the poor and most insecure people in African countries. These cereals are also favored among Sri Lankan people due to its value as health foods. *Kurakkan* (*Eleucine coracana*), *Meneri* (*Panicum miliaceum*), Sorghum (*Sorghum vulgare*) and *Thanahal* (*Setaria italica*) are underutilized minor cereals in Sri Lanka. The nutritive values are comparable with other staple cereals like wheat and rice, while some of them are even better with regards to average protein, fat and mineral contents. Therefore these are recognized as important substitutes for food shortage and meet the demand of increasing population in Sri Lanka. *Kurakkan (Ravi)*, *Meneri* (AC254), Sorghum (ICSR 94002) and *Thanahal* (935) varieties are recommended to be grown in Sri Lanka by Field Crop Research Development Institute at *Mahaillupallama*, but their utilization is limited and data on nutrient composition and antinutrients are not available for these varieties.

The reasons for limited utilization of these in Sri Lanka are the presence of antinutrients, poor digestibility of protein, carbohydrate and low palatability of these minor cereals. The sensory properties of these cereals are poor due to there coarse nature of grains and also flour due to the high fiber content. These are rich in poly phenols which influence the color and flavor. The limited availability of refined and processed millets in ready to use form has further limited use and acceptability.

These minor cereals are rich in phytic acid which is a strong chelator of important minerals such as calcium, magnesium, iron, and zinc, and therefore contribute to mineral deficiencies in people whose diets rely on these foods for their mineral intake, such as those in developing countries. It also acts as an acid, chelating the vitamin niacin, which is basic, causing the condition known as pellagra. Some nutritional studies have suggested that phytate also affects protein utilization. However, various processing treatments are known to affect the chemical composition and improve nutritive value of foods.

The present study was carried out to study the proximate composition, mineral content, the improvement in protein availability when subjected to different processing treatments and certain antinutritional compounds such as phytate. This could help to increase the protein quality of cereals. So that these could be used to improve the protein intake by incorporating into various products.

1.2 Objectives

This study was carried out with the main objective of determining the effect of processing methods on protein availability of *kurakkkan* (*Eleucine coracana*) -*Ravi*, *Meneri* (*Panicum milliaceum*) - AC254, *Thanahal* (*Setaria italica*) - 935 and Sorghum (*Sorghum vulgare*) - ICSR 94002 and selection of suitable methods for product development.

1.2.1 Specific Objectives

i. Determination of proximate composition, Fe, Ca and P content of selected varieties of minor cereals.
ii. Determination of protein efficiency ratio (PER) of raw cereals and processed cereals. Processing methods- steaming soaking and cooking etc...
iii. Determination of anti-nutrients in raw and processed cereals.

Chapter 02

Review of literature

2.1 Kurakkan – (*Eleucine coracana)*

2.1.1 Introduction

Kurakkan (*Eleusine coracana*) or finger millet (red millet) is one of the important cereal crops of the chenas in the dry zone. It belongs to family Poaceae. Finger millet is the second most important millet in Africa after pearl millet. Its nutritive value is very high especially protein, fat and minerals when compaired with rice and maize. There are many varieties and the varietal difference of *kurakkan* is based on the period of maturity, habit of growth, size, shape and color of earheads, yealding capacity, size and quality of the grain. *Kurakkan* starch is hydrolyzed in the gastrointestinal tract more slowly than rice starch and prescribed for diabetic patients (Rao, 1994).

In Sri Lanka, *Kurakkan* has been cultivated from earliest times and is considered as the second staple after rice and is one of the important cereal crops in the dry zone.

2.1.2 Habitat and distribution

Eleusine coracana is found in warm temperate regions of the world from Africa to Japan and also in Australia. It is present in archaeological records of early African agriculture in Ethiopia that date back 5000 years, and it probably originated somewhere in the area that today is Uganda. It is an important staple crop in many parts of Africa and has been cultivated in eastern and southern Africa since the beginning of the iron age. Before maize was introduced it was the staple crop of the southern African region. It was introduced to India some 3000 years ago (National Research Council 2008).

The wild form is found in areas with rainfall as low as 300 mm per annum in South Africa, but the cultivated form more commonly requires 500-1000 mm of rainfall per year. This should be well-distributed throughout the growing season and with an absence of prolonged droughts. The altitude limits of the species are unknown, but most of the cultivated finger millet in the world is found from 500-2400 m elevation. It tolerates cool climates, but thrives under hot conditions and can grow where temperatures are as high as 35°C. *Eleusine coracana* appears to be photoperiod sensitive, the optimum

photoperiod being 12 hours, which is considered to be relatively short (National Research Council 2008).

2.1.3 Botany of the plant

2.1.3.1 Taxonomy

There are about 9 species occurring in tropical and subtropical parts of the world.

Kingdom	: Plantae
Division	: Magnoliophyta
Class	: Liliopsida
Order	: Poales
Family	: Poaceae
Subfamily	: Chloridoideae
Genus	: *Eleusine*
Species	: *E. coracana*

Vernacular names: *Tailabon* (Arabic), Finger millet, African millet, *ragi*, koracan (English), *eleusine cultivee, coracan, koracan* (French), in India *Ragi* (*Kannada, Telugu*), *Taidalu* (Telangana), *Kelvaragu,Aariyam* (Tamil), *Kurakkan* (Sri Lanka), *Hong mi, Chi ke* (Vietnam), Fingerhirse (Denmark) (Rajapaksha, 1998).

2.1.3.2 Description and Morphology

Fig. 2.1 *Eleusine coracana L*