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Physical and nutritional characteristics of less common traditional rice (*Oryza sativa* L.) varieties of Sri Lanka

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ABSTRACT

Consumption and cultivation of traditional rice varieties have increased considerably in recent years due to the increased prevalence of non-communicable diseases in our country. However, the physical properties and nutritional composition of most traditional rice have not been scientifically studied to a satisfactory level. Therefore, this study determined the physical and nutritional properties of some less common rice varieties namely Pokkali, Murugakayan, Rathdel, Madathawalu, Kuruluthuda, Pachchaperumal, Suduheenati, Suwadel and Kaluheenati without subjecting to processing treatments such as polishing and parboiling. Length, width, thickness, diameter, volume and length/ width (shape) ratios as physical properties and moisture content, ash, crude fat and protein, total and digestible carbohydrate contents, resistant starch and insoluble soluble and total dietary fiber contents were determined according to standard methods. Length, width, and thickness of grains varied between 4.0-6.4 mm, 2.2-2.9 mm and 1.5-2.2 mm respectively. Diameter, volume and length-width ratio were between 2.4-3.3 mm, 3.8-10.5 mm3 and 1.7-2.6 respectively. Accordingly, the varieties were categorized as bold or medium. Moisture contents of varieties were between 5.4-8.3% and ash contents less than 2% (DM). Low crude fat (4.2-4.9% DM) and high protein (5.5-9.2% DM) contents were observed. Digestible carbohydrate and total carbohydrate contents ranged between 77.5-84.6% (DM) and 79.1-85.2% (DM) respectively. Resistant starch content varied between 0.4- 3.2%. Corresponding insoluble, soluble and total dietary fiber contents ranged between 2.8-4.9%, 1.5-2.7% and 4.3-6.5% (DM). According to the data obtained the studied traditional rice varietiesare good sources of digestible carbohydrate, protein with low fat and moisture.

KEYWORDS: *Nutritional properties, physical properties, traditional rice*

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1 INTRODUCTION

Rice (*Oryza sativa* L.) is the predominant staple in more than 20 countries in Asia, Pacific, Latin America, Caribbean, North Africa and Sub-Saharan Africa (Kennedy and Burlingame, 2003). Rice is also the single most important crop which provides 45% total calorie and 40% total protein requirement of an average Sri Lankan and the demand for rice in Sri Lanka is increasing at a rate of 1.1% per annum (RRDI, 2015). Even though more than 2000 traditional rice varieties are conserved (Dharmasena, 2010; Kennedy and Burlingame, 2003) in Sri Lanka majority of farmers cultivate about 400 varieties which are popular among consumers (Abeysekera *et al*., 2008). The increased cultivation in recent years could be due to the ability of these varieties to hold up to extreme climates and favorable response to cultivation using organic methods (Ginigaddara and Disanayake, 2018). In addition, the dietary transition due to increased morbidity and mortality due to non-communicable diseases has also contributed to increase the demand for traditional rice varieties. Currently, commercial rice farmers and rice exporters have already created a niche market among the local and international buyers due to their promising nutritional and medicinal properties recognized through colloquialism (Abeysekera *et al*., 2015; Rebeira *et al*., 2015). For instance, some traditional rice varieties are used as a remedy (in the form of *kanji*, porridge etc) in Sinhalese traditional medicine (Rambukwella and Priyankara, 2016) for various ailments.

As few studies are found in terms of quality characteristics of some traditional Sri Lankan rice (Wickramasinghe and Noda, 2008; Premakumara *et al*., 2013; Cruz and Khush, 2000), determining their nutritional properties would convey the potential of these rice varieties as a raw ingredient in food production in local and international rice markets. The data might also contribute to potential varietal improvements in future. Therefore, the present study was designed to determine the physical properties such as length, width, thickness, pericarp colour, diameter, volume and length/ width ratio (shape) and nutritional properties such as moisture, ash, crude fat and protein, digestible carbohydrates, total carbohydrate, resistant starch (RS), insoluble (IDF), soluble (SDF) and total (TDF) dietary fiber contents of selected uncooked traditional rice varieties. Rice varieties selected for the study were namely *Pokkali, Murugakayan, Rathdel, Madathawalu, Kuruluthuda, Pachchaperumal, Suduheenati, Suwadel* and *Kaluheenati*.

2 MATERIALS AND METHODS

Less commonly consumed, paddy samples (10 kg) namely *Pokkali, Murugakayan, Rathdel, Madathawalu, Kuruluthuda, Pachchaperumal, Suduheenati, Suwadel* and *Kaluheenati* harvested during*Yala* season (2017), were collected from Rice Research Institute (RRI), Bathalegoda. Paddy samples were collected into polythene bags, sealed, labelled and transported on the same day to the laboratory and stored under temperaturecontrolled conditions until processed. The paddy samples were photographed, cleaned and dehusked (SATAKE, JAPAN) and not subjected to any other treatments such as polishing. Grain classifications of rice varieties were made according to the International Rice Research Institute (IRRI) recommendation (Rice Knowledge Bank, 2019). Rice grains with lengths 5.51-6.6 or 5.5 mm or less were categorized as medium or short respectively.

2.1 Physical properties of grains

Colour of the pericarp, length, width, thickness, diameter, grain volume and shape of the grains were determined as stated below.

2.1.1 Pericarp colour of rice grains

Pericarp colour of the selected traditional Sri Lankan rice was evaluated by visual inspection (Abeysekera *et al*., 2017).

2.1.2 Length, width and thickness of rice grains

Length (L), width (W) and thickness (T) of each rice variety (five replicates of ten grains each) were determined by slide calliper. The grain was kept between the two jaws along sides and fixed. Reading was taken of the main scale and Vernier calliper collectively.

2.1.3 Equivalent diameter and grain volume

The above values were used to determine the equivalent diameter (D) and grain volume (V) of rice grain respectively (Hettiarachchi*et al*., 2016)

2.1.5Grain shape

Rice grain shape was obtained by the ratio of length and width according to the classification of IRRI (Rice Knowledge Bank, 2019) where 1.1-2 and 2.1-3.0 ratios were considered as bold and medium respectively.

2.2 Rice flour preparation

Dehusked rice was cleaned and washed using tap water. Rice was dried under the sun for 2-3 days, each day for six hours and in an oven at 55 ^{o}C for 3-4 hours before milling. Dried rice was milled (IKA ® A11 basic, New Zealand), sieved (100 mesh size) and stored (0-4^{o}C) in airtight containers until used for analyses.

2.3 Nutrient composition determination

Moisture content, ash, crude protein (AOAC, 2000) and crude fat (Croon and Fuchs, 1980 with modifications) were determined by standard methods. Carbohydrate contents (digestible carbohydrate, total carbohydrate and resistant starch) were determined according to AOAC Official Method 996.11 by Megazyme kits, Ireland (enzymatic assays). The total carbohydrate content was determined by the phenol sulphuric assay method (Dubois *et al*., 1956). Dietary fiber including insoluble and soluble dietary fiber was determined by total dietary fiber assay kit (TDF 100A-1KT, Sigma Aldrich, USA).

2.4 Statistical analysis

Data are presented as mean±SD for physical properties and nutrient composition of rice varieties. Significances were analyzed using ANOVA at 95% confidence interval with SPSS software package and Microsoft office excel 2010.

3 RESULTS AND DISCUSSION

3.1 Physical properties of traditional rice grains

Physical characteristics reflect the appearance of the rice grain and are considered as key parameters of varietal purity by breeders, sellers and consumers to select the desired variety. Physical properties of selected traditional rice are stated in table 1. Rice grains obtained after dehulling without milling and polishing were used to obtain these parameters.

Values obtained for length, width and thickness of rice varieties varied between 4.0-6.4 mm, 2.2-2.9 mm and 1.5-2.2 mm respectively. When considering the physical parameters (Table 1), *Rathdel* was the smallest ($P \leq 0.05$) rice variety out of the nine varieties studied. The highest length and width were observed in *Suduheenati* and *Kuruluthuda* respectively ($P \leq 0.05$). Thickness was highest ($P \leq 0.05$) in *Pachchaperumal* and *Kaluheenati*. The diameter of the rice grains varied between 2.4-3.3 mm where *Rathdel* had significantly ($P \leq 0.05$) lower diameter while both *Pachchaperumal* and *Kaluheenati* had significantly higher diameters ($P \leq 0.05$) among these varieties. The volume of the rice varieties was between 3.8-10.5 mm^3 with lowest ($P \leq 0.05$) in *Rathdel* which was the smallest variety with the lowest length, width, thickness and diameter. Variety *Kaluheenati* had the highest volume with higher thickness and diameter compared to other varieties studied. Length to width ratio which determines the shape of the rice varied between 1.7-2.6. Selected rice varieties were either medium or bold in shape irrespective of varying lengths and widths. Out of the nine varieties, two varieties were white in colour (*Rathdel* and *Suwadel*) and smallest while others were red (Figure 1).

Rice varieties	Length ±SD*# (mm)	Width ±SD* (mm)	Thickness ±SD* (mm)	Diameter ±SD* (mm)	Volume ±SD* (mm^3)	Length/ Width ±SD*	Shape#	Pericarp colour
Pokkali	6.1± 0.0[a]	2.5± 0.0[a]	1.7± 0.0[a]	3.0± 0.0[a]	7.4± 0.0[a]	2.5± 0.0	Medium	Red
Murugakayan	6.2± 0.0[b]	2.5± 0.0[a]	1.8± 0.0[b]	3.0± 0.0[a]	8.0± 0.1[b]	2.5± 0.0	Medium	Red
Rathdel	4.0± 0.0[c]	2.2± 0.0[b]	1.5± 0.0[c]	2.4± 0.0[b]	3.8± 0.0[c]	1.9± 0.0	Bold	White
Madathawalu	5.2± 0.0[d]	2.5± 0.0[a]	1.8± 0.0[b]	2.9± 0.0[c]	6.7± 0.0[d]	2.1± 0.0	Medium	Red
Kuruluthuda	5.3± 0.0[e]	2.9± 0.0[c]	1.8± 0.0[b]	3.1± 0.0[d]	8.3± 0.1[e]	1.9± 0.0	Bold	Red
Pachchaperumal	5.7± 0.0[f]	2.8± 0.0[d]	2.2± 0.0[d]	3.3± 0.0[e]	10.1± 0.0[f]	2.0± 0.0	Bold	Red
Suduheenati	6.4± 0.0[g]	2.5± 0.0[a]	1.7± 0.0[a]	3.1± 0.0[d]	8.4± 0.0[g]	2.6± 0.0	Medium	Red
Suwadel	4.1± 0.0[h]	2.5± 0.0[a]	1.6± 0.0[e]	2.6± 0.0[f]	4.9± 0.0[h]	1.7± 0.0	Bold	White
Kaluheenati	6.0± 0.0[i]	2.8± 0.0[d]	2.2± 0.0[d]	3.3± 0.0[e]	10.5± 0.1[i]	2.1± 0.0	Medium	Red

Table 1. Physical properties of rice grains

*N=10x5; SD-Standard Deviation; #-Classified according to IRRI; Different superscripts in columns indicate significances at 95% confidence interval


Pokkali


Pokkali


Murugakayan


Murugakayan


Rathdel


Rathdel


Madathawalu


Madathawalu


Kuruluthuda


Kuruluthuda


Pachcaperumal


Pachcaperumal


Suduheenati


Suduheenati


Suwadel


Suwadel


Kaluheenati


Kaluheenati

Figure 1: Paddy and dehulled grains of selected traditional rice

All of the selected rice varieties of this study were either medium (5.51-6.6 mm) or short (<5.50 mm) in length (Table 1) according to the classification adopted by IRRI (Rice Knowledge Bank, 2019). Thilakarathna *et al.* (2018) for *Suwadel* and Abeysekera *et al*. (2017) for *Rathdel, Madathawalu, Pachchaperumal, Suduheenati* and *Kaluheenati* reported similar results. However, the results obtained for physical properties in the present study were different from the results of Hettiarachchi *et al*. (2017) and Rebeira *et al*. (2015) for *Pachchaperumal* and *Kaluheenati* (short grains) and *Madathawalu* (medium grain). In the present study classification of *Pachchaperumal* and *Kaluheenati* was as medium and *Madathawalu* as short, similar to Thilakarathna *et al*. (2018) and Abeysekera *et al*. (2017). Some Bangladesh and Thai rice varieties were of medium and long length (6.6-7.5 mm) and all the varieties belonged to either slender or bold shape according to length/width ratio (Chapagai *et al*., 2017). Varieties *Pokkali, Murugakayan, Suduheenati* and *Kaluheenati* would be more popular as medium grains are more preferred in countries of Southeast Asia including Sri Lanka (Juliano, 1985; Juliano 2003).

Significant positive correlations between length and diameter (P= 0.001) and length and shape (P= 0.001) were observed. A positive correlation of grain length with shape was reported by Wadchararat *et al*. (2006), Thongbam *et al*. (2010) and Rasool *et al*. (2015). These results indicate that increased length is associated with the slender shape.

Table 2. Moisture, ash, crude fat and protein of selected rice flour (g/100g dry weight)

Traditional rice variety	Moisture± SD*%	Ash± SD*%	Crud fat± SD**%	Crude protein± SD***%
Pokkali	6.6± 0.2^{a}	1.2± 0.1^{a}	4.7± 0.3^{abd}	9.2± 0.2^{a}
Murugakayan	6.7± 0.4^{a}	1.2± 0.1^{a}	4.8± 0.3^{ab}	6.2± 0.2^{b}
Rathdel	6.8± 0.1^{a}	1.3± 0.1^{a}	4.9± 0.2^{a}	7.1± 0.3^{c}
Madathawalu	5.4± 0.1^{b}	1.6± 0.1^{b}	4.6± 0.0^{b}	7.7± 0.1^{d}
Kuruluthuda	7.0± 0.4^{a}	1.2± 0.1^{a}	4.2± 0.1^{c}	8.6± 0.3^{e}
Pachchaperumal	5.0± 0.2^{b}	1.4± 0.1^{ab}	4.3± 0.1^{cd}	6.7± 0.2^{c}
Suduheenati	8.3± 0.0^{c}	1.2± 0.1^{a}	4.4± 0.2^{cd}	5.5± 0.2^{f}
Suwadel	8.6± 0.3^{c}	1.3± 0.1^{a}	4.6± 0.2^{abd}	8.4± 0.2^{e}
Kaluheenati	6.8± 0.2^{a}	1.4± 0.1^{ab}	4.2± 0.3^{cd}	8.1± 0.2^{e}

*n=6; **n=5; ***n=3; SD: Standard Deviation; Different superscripts in columns indicate significances at 95% confidence interval

3.2 Proximate composition of rice

Moisture, ash, crude fat and protein of the studied rice varieties are stated in table 2. The moisture content of rice flour varied between 5.0-8.6%. Varieties *Pachchaperumal* and *Madathawalu* contained least ($P \leq 0.05$) moisture whereas *Suwadel* and *Suduheenati* had the highest moisture ($P \leq 0.05$) contents among these varieties. The moisture content of the rice grain is an essential parameter which determines the keeping quality, milling quality and cooking and processing qualities of rice (Juliano, 2003). For storage moisture content must be kept lower than 14% or else the grain quality deteriorates (Juliano, 1985; Juliano, 2003). In the present study, the moisture contents of studied rice flour were less than 14%. Thus these varieties have the added advantage of being able to be stored for longer periods. According to Kulasinghe *et al*. (2019), Abeysekera *et al*. (2017) and Kariyawasam *et al*. (2016) the moisture contents of air-dried rice were more than 11% for selected traditional rice varieties which is higher than the moisture of the present study. In the present study, the rice grains have been dried in the oven for a few hours following air drying and prior to milling. Studies of Hettiarachchi *et al*. (2014) and Gunathilaka and Ekanayake, (2015) reported moisture contents more or less similar to the present study although the rice varieties were high yielding and basmati types.

Ash content which reflects the mineral content of uncooked rice flour varied between 1.2-1.6%. Values obtained for ash content of traditional rice by Kariyawasam *et al*. (2016) and Samaranayake *et al*. (2017) correlate with present study data. Both traditional and high yielding rice varieties have exhibited similar ash values (Kulasinghe *et al*., 2019; Samaranayake *et al*., 2017), except for *Kuruluthuda* (2.95%) and *Madathawalu* (2.16%). However, in the present study also *Madathawalu* contained the highest ash ($P \leq 0.05$) among the nine varieties. The ash contents by Abeysekera *et al*. (2017) for the same varieties were slightly higher. The mineral content of rice could vary due to soil conditions and also the fertilizer application (Syafutri *et al*., 2016).

The crude fat content of rice varieties varied within a small range (4.2-4.9% DM) and was less than 5% DM. The smallest rice, *Rathdel* and *Murugakayan* and *Pokkali* varieties had the highest ($P \leq 0.05$) crude fat contents out of the studied varieties. In the present study, crude fat values obtained were higher compared to other reported studies. Values for lipid content vary with the method of analysis (Zhou *et al*., 2002). In the present study, the discontinuous solvent extraction method was used to determine fat while many other researchers have used soxhlet extraction. Soxhlet extraction uses continuous flow and needs more time to extract under heating (Doria *et al*., 2009) where some fat could be oxidized/evaporated. The crude fat content of most reported studies on the fat content of rice that did not exceed 3% (Kulasinghe *et al*., 2019; Kariyawasam *et al*., 2016; Abeysekera *et al*., 2017 Gunaratne *et al*., 2011) were determined using the soxhlet method. Further, unmilled rice retains both the bran and germ which accommodate fat present in the grain (Chapagai *et al*., 2017). Thai rice varieties have shown similar amount of crude fat for rice flour (3.63-4.51g/100g) as in the present study but have obtained lower results for Sri Lankan red rice obtained from the market where the fat content was determined by gravimetric method (Sompong *et al*., 2011). The lower value could be due to the market rice being polished.

Lowest and highest (P≤0.05) crude protein contents were in *Suduheenati* (5.5%) and *Pokkali* (9.2%) respectively (Table 2). The protein content of rice flour of the present study was similar to Kulasinghe *et al*. (2019) and Samaranayake *et al*. (2017). However, according to Kariyawasam *et al*. (2016), *Pokkali* and *Kaluheenati* varieties had higher quantities of crude protein than observed in the present study. Crude protein contents of traditional rice including some varieties studied in the present study were higher (11-13.5%) than observed in the present study (Abeysekera *et al*., 2017). Gunaratne *et al*. (2011) have stated that traditional varieties contain more protein than improved varieties. This was apparent according to the results of Wathupola, (2017), Hettiaratchi *et al*. (2009) and Nisanka and Ekanayake, (2016) where high yielding varieties had lower protein than traditional varieties. Further, depending on the degree of polishing protein content decreases from raw rice at least by 6.7% due to removal of the aleurone layer (Juliano, 1985).

Digestible and un-digestible carbohydrates comprised more than 80% of the grain weights. Digestible carbohydrate was the major nutrient in all the traditional rice varieties (Table 3) and varied between 77.5-84.6%. Varieties Pokkali, Rathdel and Pachchaperumal had the highest (P≤0.05) content of digestible carbohydrate. The total carbohydrate content of rice varied between 78.7- 85.2% when determined by both enzymatic digestion and phenol sulphuric (chemical) methods. Highest (P≤0.05) total carbohydrate contents were observed in Pokkali (85.2%), Rathdel and Pachchaperumal similar to digestible carbohydrate contents whereas Suwadel had the least (79.1%) total carbohydrate content (P≤0.05). Carbohydrate content of un-processed traditional rice determined by difference varied between 72.0-82.74% (Samaranayake et al., 2017; Kulasinghe et al., 2019). Samaranayake et al. (2017) reported higher values while Kulasinghe et al. (2019) reported lower values compared to the present study. The variations could be due to the difference in estimating carbohydrate content (by difference). The digestible carbohydrate content of several traditional rice varieties determined using enzymatic assay had more or less similar results to the present study (Gunaratne et al., 2011). The digestible and total carbohydrate content of high yielding raw and parboiled rice flour obtained by the same method of analyses were lower (Darandakumbura, 2013) when compared to the traditional rice studied in the present study. Basmati varieties had comparable digestible carbohydrate contents to the present study which had been determined using enzymatic digestion (Gunathilaka and Ekanayake, 2015).

Table 3. Digestible carbohydrate, total carbohydrate, resistant starch, insoluble, soluble and total fiber contents of rice flour (g/100g dry weight)*

*n=4; SD-Standard Deviation; ED-enzymatic digestion method; PS-Phenol sulphuric method for total carbohydrate; Different superscripts in columns indicate significances at 95% confidence interval

Traditional rice variety	Digestible carbohydrate ± SD%	Total carbohydrate± SD (ED) %	Resistant starch± SD%	Total carbohydrate±SD (PS)%	Insoluble fiber ± SD%	Soluble fiber ± SD%	Total fiber ± SD%
Pokkali	84.6± 0.6^{a}	85.2± 0.2^{a}	0.7± 0.2^{a}	83.1± 0.7^{ac}	2.8± 0.2^{a}	1.5± 0.2^{a}	4.3± 0.1^{a}
Murugakayan	82.3± 0.9^{b}	83.5± 0.6^{b}	1.3± 0.4^{ba}	82.1± 1.0^{ac}	4.0± 0.6^{bc}	1.5± 0.2^{a}	5.4± 0.5^{b}
Rathdel	84.0± 0.3^{a}	84.9± 0.1^{a}	0.8± 0.1^{ab}	83.3± 0.9^{a}	3.4± 0.3^{bd}	1.9± 0.1^{b}	5.3± 0.4^{b}
Madathawalu	79.1± 0.9^{c}	79.8± 0.1^{c}	0.8± 0.1^{ab}	78.7± 1.3^{b}	4.4± 0.8^{bc}	1.8± 0.5^{ab}	6.2± 0.6^{bc}
Kuruluthuda	78.9± 1.1^{cd}	79.3± 0.1^{d}	0.4± 0.2^{a}	80.5± 1.7^{ab}	4.9± 0.5^{c}	1.6± 0.3^{ab}	6.5± 0.5^{c}
Pachchaperumal	84.0± 0.6^{a}	84.7± 0.3^{a}	0.7± 0.1^{a}	83.1± 1.6^{a}	3.7± 0.3^{bd}	2.7± 0.1^{c}	6.5± 0.2^{c}
Suduheenati	77.5± 1.3^{d}	80.6± 0.6^{e}	3.2± 0.6^{c}	80.8± 0.8^{b}	3.9± 0.2^{b}	1.9± 0.3^{b}	5.8± 0.5^{bc}
Suwadel	78.1± 0.6^{d}	79.1± 0.4^{d}	1.0± 0.3^{ab}	79.7± 1.4^{cb}	3.3± 0.1^{d}	2.4± 0.4^{cb}	5.7± 0.4^{bc}
Kaluheenati	80.2± 2.3^{bcd}	81.6± 0.1^{e}	1.4± 0.1^{b}	80.3± 1.0^{cb}	3.5± 0.3^{bd}	1.8± 0.4^{ab}	5.3± 0.4^{b}

Resistant starch (RS) contents of rice flour ranged between 0.4- 3.2% where *Suduheenati* contained the highest (P≤ 0.05) amount. Except for *Murugakayan*, *Suduheenati*, *Suwadel* and *Kaluheenati* other varieties had less than 1% of RS. Varieties *Rathdel*, *Suduheenati* and *Suwadel* had similar RS values with reported data but *Kuruluthuda*, *Pachchaperumal* and *Kaluheenati* had higher values (Abeysekera *et al*., 2017) than reported in the present study where the RS content had been determined directly. Rice samples for this study had been obtained from experimental fields of Rice Research and Development Center, Bombuwala. Improved rice varieties had more than 4% RS when analyzed according to the same method as in the present study (Gunaratne *et al*., 2013). The different geographical locations from which the rice has been obtained and the level of polishing the rice subjected to may have contributed to the observed differences.

The total dietary fiber contents of studied rice were more than 4% (Table 3). Insoluble dietary fiber content varied between 2.8- 4.9% (DM) whereas soluble fiber content varied between 1.5-2.7% (DM). Varieties *Kuruluthuda* (4.9%) and *Pachchaperumal* (2.7%) scored the highest values for insoluble and soluble fiber respectively and contained the highest dietary fiber among the varieties studied. Dietary fiber contents of *Kuruluthuda* (4.88%) and *Suwadel* (6.28%) determined by the same method as used in this study were similar to the data of the present study. These varieties have been obtained from a private institute (Samaranayake *et al*., 2017). The total dietary fiber content of *Rathdel* was similar but higher in *Suduheenati* (Abeysekera *et al*., 2017). However, some rice obtained from the market (Thailand, China and Sri Lankan red rice) had similar dietary fiber contents (Sompong *et al*., 2011) for other varieties whereas lower values were obtained for Sri Lankan rice which could be due to the polishing of the market rice.

4 CONCLUSIONS

The selected rice varieties in the present study were dehulled and not subjected to any other treatment. Shapes of the raw grains of the studied varieties were either medium or bold. The increased length was associated more with slender shape. When considering the nutritional potential the results indicated that the selected traditional rice varieties are good sources of carbohydrate and protein with low fat and moisture. Thus consumption of whole rice will be nutritionally advantageous. The low moisture increases the duration of storage of these varieties. Therefore, these rice varieties have the potential to be utilized as flour in the production of low-fat food products or replace wheat flour to a certain extent.

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REFERENCES

Abeysekera, W. K. S. M., Arachchige, S. P. G., Ratnasooriya, W. D., Chandrasekharan, N. V. and Bentota, A. P. 2017. Physico-chemical and nutritional properties of twenty three traditional rice (*Oryza sativa* L.) varieties of Sri Lanka. *Journal of Coastal Life Medicine*, vol. 5, no. 8, pp.343–349.

Abeysekera, W. K. S. M., Arachchige, S. P. G., Ratnasooriya, W. D., Choudhary, M. I., Dalvandi, K.and Chandrasekharan, N. V. 2015. Anti-diabetic related health food properties of traditional rice (*Oryza sativa*

L.) in Sri Lanka. *Journal of Coastal Life Medicine*, vol. 3, no. 10, pp.815–820.

Abeysekera, W. K. S. M., Somasiri, H. P. P. S., Premakumara, G. A. S., Bentota, A. P., Rajapakse, D. and Ediriweera, N. 2008. Cooking and eating quality traits of some Sri Lankan traditional rice varieties across Yala and Maha seasons. *Tropical Agricultural Research* 20, pp.168–176.

Association of Official Analytical Chemists 2000. Official Methods of Analysis of the AOAC. 17th ed.; AOAC International. Maryland, USA.

Chapagai, M. K., Wan Rosli, W. I., Wan Manan, W. M., Jalil, R. A., Karrila, T. and Pinkaew, S. 2017. Effect of domestic cooking methods on physicochemical, nutritional and sensory properties of different varieties of brown rice from Southern Thailand and Malaysia. *International Food Research Journal* , vol. 24, no. 3, pp.1140–1147.

Cruz, D.N. and Khush, G.S. 2000. Rice grain quality evaluvation procedures. In: R.K. Singh U.S. Singh and G.S. Khuh ed, *Aromatic Rice.* New Delhi and Calcutta: Oxford and IBH Publishing Co Pvt. Ltd. Ch. 3.

Croon, L.B. and Fuchs, G. 1980. Fatthaltsbestamning I mjol och mjolprodketer (Crude fat analysis of different flours and flour products). *Var Foda* 32, pp.425-427.

Darandakumbura H.D.K., Prasantha B.D.R. and Wijesinghe D.G.N.G. 2013. Effect of processing condition and polishing rate on apparent amylose content of some Sri Lankan rice varieties. *Tropical Agricultural Research*, vol. 24, no. 4, pp.317-324.

Dharmasena, P. B. 2010. Traditional rice farming in Sri Lanka. *Economic Review* vol. 36, pp.48–53.

Doria E, Galleschi L, Calucci L, Pinzino C, Pilu R, Cassani E. and Nielsen E. 2009. Phytic acid prevents oxidative stress in seeds: evidence from a maize (*Zea mays* L.) low phytic acid mutant. *Journal of Experimental Botany*, vol. 60, pp.967–978.

Dubois, M., Gilles, K. A., Hamilton, J. K., Rebers, P. A. and Smith, F. 1956. Colorimetric method for determination of sugars and related substances. *Analytical Chemistry*, vol. 28, pp.350–356.

Ginigaddara, G. A. S. and Disanayake, S. P. 2018. Farmers’ willingness to cultivate traditional rice in Sri Lanka: A case study in Anuradhapura District. In: F. Shah, Z. H. Khan and A. Iqbal ed, *Rice Crops Current Development.* London: IntechOpen Limited. Ch 13.

Gunaratne, A., Bentota, A., Cai, Y. Z., Collado, L.and Corke, H. 2011. Functional, digestibility, and antioxidant properties of brown and polished rice flour from traditional and new-improved varieties grown in Sri Lanka. *Starch/Starke,* vol. 63, no. 8, pp.485–492.

Gunaratne, A., Kao, W., Ratnayaka, J., Collado, L. and Corke, H. 2013b. Effect of parboiling on the formation of resistant starch, digestibility and functional properties of rice flour from different varieties grown in Sri Lanka. *Journal of the Science of Food and Agriculture*, vol. 93, no. 11, pp.2723–2729.

Gunathilaka, M. D. T. L. and Ekanayake, S. 2015. Effect of different cooking methods on glycaemic index of Indian and Pakistani basmati rice varieties. *Ceylon Medical Journal* vol. 60, no. 2, pp.57-61.

Hettiarachchi, H. A. P. W., Ribeira, S. P., Prasantha, B. D. R. and Wickramasinghe, H. A. M. 2016. Diversity of physical and cooking quality characters of selected traditional and improved rice varieties in Sri Lanka. *Sri Lankan Journal of Biology* vol.1, no. 1, pp.15-26.

Hettiarachchi, P., Jiffry, M., Jansz, E., Wickramasinghe, A. and Fernando, D. 2014. Glycaemic indices of different varieties of rice grown in Sri Lanka. *Ceylon Medical Journal,* vol. 46, no. 1, 1pp.1-14.

Hettiaratchi, U., Ekanayake, S. and Welihinda, J. 2009. Do Sri Lankan meals help decrease blood glucose response? *Ceylon Medical Journal,* vol. 54, no. 2, pp.39–45.

Juliano, B. O. 1985. Criteria and tests for rice grain qualities. In: B. O. Juliano ed, *Rice: Chemistry and technology*, Minnesota: American Association of Cereal Chemists.Ch.12.

Juliano, B.O. 2003. Production and utilization.In: B. O. Juliano ed, *Rice Chemistry and Quality*, Manila: Island Publishing House. Ch.1

Kariyawasam, T. I., Godakumbura, P. I., Prashantha, M. A. B. and Premakumara, G. A. S. 2016. Proximate composition, calorie content and heavy metals (As, Cd, Pb) of selected Sri Lankan traditional rice (*Oryza sativa* L.) varieties. *Procedia Food Science,* vol. 6, pp.253–256.

Kennedy, G. and Burlingame, B. 2003. Analysis of food composition data on rice from a plant genetic resources perspective.Analytical, nutritional and clinical methods. *Food Chemistry,* vol.80, pp.589–596.

Kulasinghe, A., Samarasinghe, G., Wimalasiri, S., Silva, R. and Madhujith, T. 2019. Macronutrient and mineral composition of selected traditional rice varieties in Sri Lanka. *Proceedings of the International Conference on Food Quality, Safety and Security,* vol.1, pp.1–8.

Nisanka, T. U. S. and Ekanayake, S. 2016. Rice variety and processing: contribution to glycaemic response. *Ceylon Medical Journal,* vol. 61, no. 4, pp.159-162.

Premakumara G. A. S., Abeysekera W. K. S. M., Ratnasooriya W. D., Chandrasekharan N. V., and Bentota A.P. 2013. Antioxidant, anti-amylase and anti-glycation potential of brans of some Sri Lankan traditional and improved rice (*Oryza sativa* L.) varieties. *Journal of*

Cereal Science, vol. 58, pp.451-456

Rambukwella, R. and Priyankara, E. A. C. 2016. Production and marketing of traditional rice varieties in selected districts in Sri Lanka: Present status and future prospects. Colombo: Hector Kobbekaduwa Agrarian Research and Training Institute.

Rasool, N., Baba, W. N., Muzzaffar, S., Masoodi, F. A., Ahmad, M., and Bhat, M. M. 2015. A correlation study of proximate composition, physical and cooking properties of new high yielding and disease resistant rice varieties. *Cogent Food* and *Agriculture*, vol. 15, no. 1, pp.1–9.

Rebeira, S. P., Wickramasinghe, H. A. M., Samarasinghe, W. L. G. and Prashantha, B. D. R. 2015. Diversity of grain quality characteristics of traditional rice (*Oryza sativa* L.) varieties in Sri Lanka. *Tropical Agricultural Research*, vol. 25, no. 4, pp.570-578.

Rice Knowledge Bank: Procedures for Measuring quality of milled rice. Available from: http://www.knowledgebank.irri.org/rkb/quality-characteristics-of-milled-rice/procedures-formeasuring-quality-of-milled-rice.html. [June 16, 2020]

Samaranayake, M. D., Abeysekera, W. K. S., Liyanage, S., Premakumara, G. A., Abeysekera, W. P. K. and Abeysiriwardena, D. S. de. Z. 2017. Physicochemical and nutritional properties of selected pigmented and white long grain rice varieties of Sri Lankan at different polishing rates. *Research Journal of Chemical Sciences*, vol. 8, no. 5, pp.29-35.

Samaranayake M.D.W., Yathursan S., Abeysekera W.K.S.M. and Herath, H.M.T. 2017. Nutritional and antioxidant properties of selected traditional rice (*Oryza sativa* l.) varieties of Sri Lanka. *Sri Lankan Journal of Biology*, vol.2, no. 2, pp.1–10.

Sompong, R., Siebenhandl-Ehn, S., Linsberger-Martin, G. and Berghofer, E., 2011. Physico-chemical and antioxidative properties of red and black rice varieties from Thailand, China and Sri Lanka. *Food Chemistry*, vol. 124, no. 1, pp.132–140.

Syafutri M. I., Pratama, F., Sayiful, F. and Faizal, A. 2015. Effects of varieties and cooking methods on physical and chemical characteristics of cooked Rice. *Journal of Rice Science*, vol. 23, no. 5, pp.282- 286.

Thilakarathna, G. C., Navarathne, S. B. and Wickramasinghe, I. 2018. Identification of important physical properties and amylose content in commercially available improved and traditional rice varieties in Sri Lanka. *International Journal of Advanced Engineering Research and Science*, vol.4, no. 12, pp.186–194.

Thongbam, Premila D., Durai, A. Anna, Singh, Anand, Taorem, Bidyapati Devi, Gupta, S., Mitra, J., Pattanayak, A., Dhiman, K.R., Bhadana, V.P., Hore, D.K. and Ngachan, S.V. 2010. Grain and food quality traits of some indigenous medicinal rice cultivars of Manipur. *International*

Journal of Food Properties, vol.13, no. 6, pp.1244-1255.

Wadchararat, C., Thongngam, M. and Naivikul, O. 2006. Characterization of pregelatinized and heat moisture treatedrice flours. *Kasetsart Journal - Natural Science*, vol.40, pp.144–153.

Wathupola, A. 2012 Nutritional quality of some popular sri lankan starchy foods. (M Sc.Thesis) University of Colombo, Sri Lanka.

Wickramasinghe, H. A. M. and Noda, T., 2008. Physicochemical properties of starches from Sri Lankan rice varieties. *Food Science and Technology Research*, vol.14, no. 1, pp.49–54.

Zhou, Z., Robards, K., Helliwell, S. and Blanchard, C. 2002. Composition and functional properties of rice. *International Journal of Food Science and Technology*, vol. 37, no. 8, pp.849–868.