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Research Article
Nutritional Composition of Cassava Cultivar "CARI-555"

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Abstract

Background: Humid tropical root crop cassava (*Manihot esculenta*) is one of the most important metabolic sources of calories. The root, which consists of outer phelloderm (peel), parenchyma (starchy bulk of the root) and central vascular core is the main commercial product of cassava. **Objective:** The present study was conducted to analyze the proximate composition (moisture, ash, total fat, crude fibre, protein and carbohydrate) in the peel and the flesh of cassava cultivar "CARI-555". **Materials and Methods:** The proximate composition (moisture, ash, crude fibre, crude protein and total fat) of the six samples was determined using standard methods with three replicates. The carbohydrate content was calculated by the difference. **Results:** The moisture, ash, fat, crude protein, crude fibre and carbohydrates amounts of the flesh sample were 52.70±0.52, 0.87±0.06, 1.87±0.68, 0.91±0.16, 0.91±0.02 and 42.74±0.46%, respectively. The moisture, ash, fat, crude protein, crude fibre and carbohydrates amounts of the phelloderm (peel) sample were 58.88±0.25, 1.00±0.05, 1.34±0.18, 1.23±0.08, 1.72±0.03 and 35.83±0.22%, respectively. A negative correlation was significantly exist ($p<0.05$) in between the moisture, fat and ash content of flesh. The fat content in the flesh was correlated positively and significantly with the fat content of the peel. **Conclusion:** This study revealed that cassava cultivar "CARI-555" is a good source of carbohydrate and its root flesh contain significantly high amount of carbohydrate than the peel where the peel contain significantly high amount of moisture, ash, crude protein and crude fibre than the root flesh.

Key words: Cassava, proximate composition, macro-nutrients, CARI-555, cassava peel, cassava flesh

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Humid tropical root crop cassava (*Manihot esculenta*) can be grown in low nutrient soils and drought conditions[1]. For the millions of people in tropics, cassava is one of the most important metabolic sources of calories[2] and it is the third most grown plant in the sub-tropical and tropical areas of Africa[3]. The root which consists with outer phelloderm (peel), parenchyma (starchy bulk of the root) and central vascular core is the main commercial product of cassava[4].

Cassava was first introduced[5] to Sri Lanka in 1786 and the recent records of Sri Lanka have shown that, the estimated annual production of cassava in year 2014 is 302,767 Mt and the area of land under cultivation of cassava is 23,970 ha[6].

In 1988 the Department of Agriculture in Sri Lanka released its first cassava cultivar, CARI-555, which is with very high farmer acceptance due to desirable characters like good plant type, high yield potential and good culinary qualities[5].

The present study was conducted to analyse the proximate composition (moisture, ash, total fat, crude fibre, crude protein and carbohydrate) in the peel and the flesh of cassava cultivar "CARI-555" in order to increase its use as food and the industrial utilization of selected cassava cultivar.

MATERIALS AND METHODS

Sample collection and preparation: Samples were collected from the experimental fields of Horticultural Crop Research and Development Institute (HORDI), Gannoruwa, Sri Lanka. Six healthy plants of CARI-555 variety in the 12 months of maturity stage after planting was selected. The roots of the plants were harvested without damaging to the roots and immediately they were packed separately in well ventilated six plastic crates and labelled on site. Then the samples were immediately transported to the Food Science and Technology Laboratory of the Department of Food Science and Technology, University of Sri Jayewardenepura. Soil particles on the root samples were removed by dry brushing and the samples were packed in labelled polyethylene bags and transferred to refrigerator at 4-0°C for storing until taken to analysis (maximum 2 weeks).

Proximate composition analysis of samples: The peel was removed from the roots and collected separately. The upper epidermis of the peel was removed and the rest of the peel was taken to analysis. The peel and the flesh was grounded using mortar and pestle to reduce the particle size and taken to analysis. The proximate composition (moisture, ash, crude fibre, crude protein and total fat) of the six samples was determined using standard methods with three replicates[7].

Oven dried method was used to determine the moisture content and protein content was analyzed by using micro Kjeldhal method of nitrogen analysis. The crude protein in the samples was obtained by multiplying the nitrogen content of the sample from a conversion factor 6.25.

Ash content was determined gravimetrically by ashing 1 g of each sample into reweighed porcelain crucibles in a Muffle furnace at 550°C for 24 h. Total fat or crude fat content of each sample was determined by extracting the fat of the dried food material with HCl acid.

The crude fibre content was determined by boiling approximately 2 g of the sample with 0.1 M sulphuric acid and 0.1 M sodium hydroxide respectively and filtered the content through a Buchner funnel in to a ashless filter paper. Then filter paper with the filter bed was dried and ashed at 550°C.

Carbohydrate content was calculated with following formula:

Carbohydrate content = 100-(moisture+ash+protein+fat+crude fibre)

Statistical analysis: The data were analyzed using MINITAB 14 statistical software. The results of proximate composition were subjected to normality test for examine whether the observations were normally distributed. The compositions of flesh and peel were analyzed using paired t-test at 95% confident level. Simple linear correlation coefficients were determined for proximate composition parameters. The relationship between proximate composition parameters of the peel and the flesh was predicted using a linear regression model ($p<0.05$)[8].

RESULTS AND DISCUSSION

The results of Anderson-Darling normality test revealed that the observations of proximate analysis were normally distributed ($p>0.05$). Therefore paired t-test was performed to analyse whether the mean nutrient values of the peel and the flesh of CARI-555 variety were significantly different at 95% confident level.

Results of paired t-test: The proximate compositions of moisture, ash, crude protein, crude fibre and carbohydrate content of cassava variety, CARI-555, showed significant difference between the flesh and the phelloderm (peel) (Fig. 1). But there was no significant difference exists in

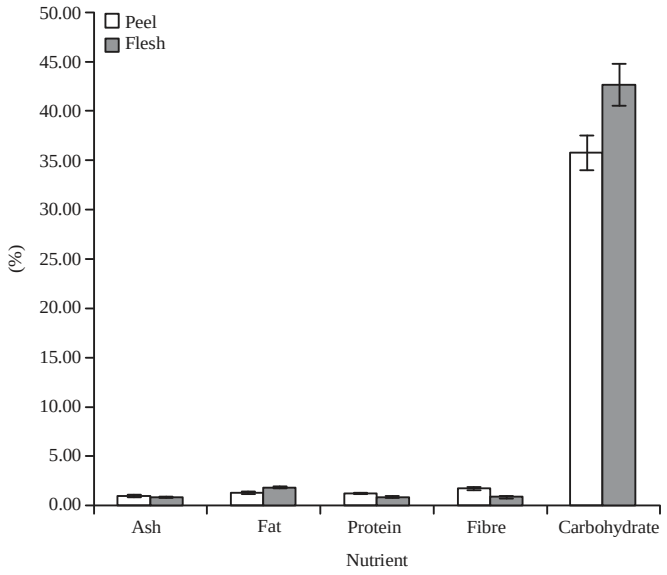

Fig. 1: Proximate compositions in the root flesh and the root peel of cassava variety "CARI-555" wet basis

Table 1: Proximate compositions in the root flesh and the root peel of cassava variety "CARI 555" wet basis

Variables	Flesh	Peel
Moisture	52.70±0.52[a]	58.88±0.25[b]
Ash	0.87±0.06[a]	1.00±0.05[b]
Fat	1.87±0.68[a]	1.34±0.18[a]
Crude protein	0.91±0.16[a]	1.23±0.08[b]
Crude fibre	0.91±0.02[a]	1.72±0.03[b]
Carbohydrates	42.74±0.46[a]	35.83±0.22[b]

Data are expressed as Mean±SD followed by the same letter, within a row, are not significantly different (p>0.05)

between the fat content of the root flesh and the peel. The root flesh contain significantly high amount of carbohydrate than the peel where the peel contain significantly high amount of moisture, ash, crude protein and crude fibre than the root flesh. These results were comparable with the findings of Montagnac *et al.*[9] who reported that the protein, fat and fibre contents were found in larger quantities in the root peel than in the peeled root and the flesh has higher amount of carbohydrates. The results are also comparable with the observations of Somendrika *et al.*[10] on the study of proximate compostion analysis of Sri Lankan cassava variety Kirikawadi. But the CARI-555 flesh contains high amount of fat than the peel even though the difference was not significant which was not comparable with the results of Somendrika *et al.*[10] may be a result of varietal changes.

The moisture, ash, fat, crude protein, crude fibre and carbohydrates amounts of the flesh sample were 52.70±0.52, 0.87±0.06, 1.87±0.68, 0.91±0.16, 0.91±0.02 and 42.74±0.46% (Table 1). The ash, protein and fibre contents were comparable with the values recorded by Somendrika *et al.*[10] in the study of Sri Lankan cassava varity Kirikawadi (ash 1.29-1.35%, crude protein 0.63-0.81% and crude fibre 0.88-0.92%) and with the proximate compositions recorded as ash 0.4-1.7%, crude protein 0.03-3.5%, crude fibre 0.1-3.7% in the review on nutritional value of cassava for use as a staple food[9].

The proximate compositions of cassava cultivar "CARI-555" were less than the values recorded in the study on comparative analysis on the nutritional and anti-nutritional contents of the sweet and bitter cassava varieties[11], that may be a result of the changes in preparing samples. The peeled roots had dried at 40°C for 18 h and the dried samples had ground to form a powder and the dried powder had taken for the analysis in the study of Sarkiyayi and Agar[11]. In the current study the peeled root was crushed with mortar and pestle to reduce the particle size and had taken for the analysis.

The moisture, ash, fat, crude protein, crude fibre and carbohydrates amounts of the phelloderm (peel) sample were 58.88±0.25, 1.00±0.05, 1.34±0.18, 1.23±0.08, 1.72±0.03 and 35.83±0.22% (Table 1). The observed values are tallied with the values reported in proximate composition analysis of cassava variety Kirikawadi peel as moisture, ash, fat, crude protein, crude fibre and carbohydrates amounts 72.63±0.67, 1.20±0.04, 0.68±0.08, 1.73±0.09, 2.31±0.02 and 21.45±0.72%, respectively[10]. The observed values are lower than those reported by Okpako *et al.*[12], Oboh[13] and Somendrika *et al.*[14]. That might be because of the ranges were on dry basis and the varietal changes of cassava cultivars.

Table 2: Correlation matrix for proximate composition contents in cassava peels and flesh

Parameters	Moisture flesh	Moisture peel	Ash flesh	Ash peel	Fat flesh	Fat peel	Protein flesh	Protein peel	Fibre flesh	Fibre peel	Carbohydrate flesh	Carbohydrate peel
Moisture flesh	1.000											
Moisture peel	0.212	1.000										
Ash flesh	-0.921	-0.365	1.000									
Ash peel	-0.816	-0.591	0.776	1.000								
Fat flesh	-0.880	-0.441	0.747	0.823	1.000							
Fat peel	-0.729	-0.620	0.632	0.750	0.956	1.000						
Protein flesh	-0.265	-0.242	0.212	-0.009	0.478	0.610	1.000					
Protein peel	0.083	-0.517	-0.176	0.074	0.391	0.609	0.643	1.000				
Fibre flesh	0.100	-0.008	-0.231	0.316	-0.071	-0.154	-0.780	-0.162	1.000			
Fibre peel	-0.187	0.191	0.293	-0.024	0.126	0.034	-0.047	-0.081	-0.192	1.000		
Carbohydrate flesh	0.403	0.541	-0.259	-0.444	-0.779	-0.903	-0.730	-0.876	0.194	0.020	1.000	
Carbohydrate peel	0.535	-0.353	-0.252	-0.182	-0.618	-0.496	-0.442	-0.264	0.150	-0.359	0.526	1.000

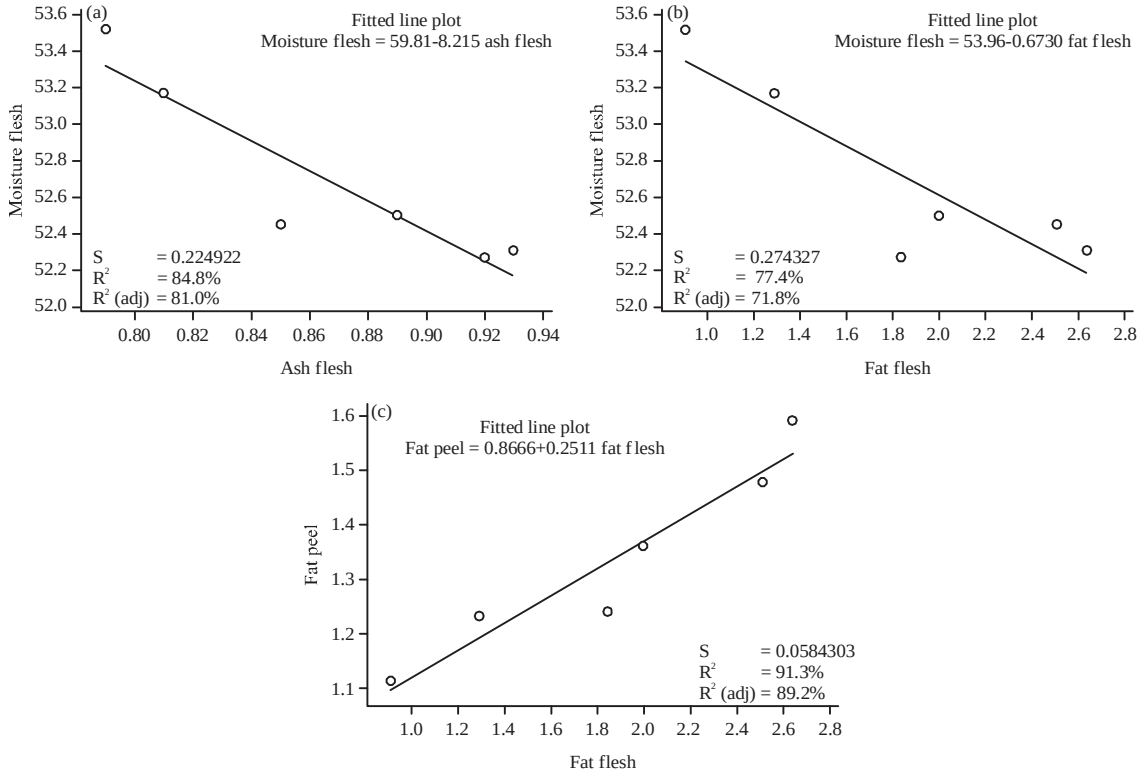

Fig. 2(a-c): Relationship between proximate composition parameters, (a) Moisture in flesh and ash in flesh, (b) Moisture in flesh and fat in flesh and (c) Fat in peel and fat in flesh

Results of correlation analysis: Table 2 illustrates the correlation matrix for the proximate composition contents in peel and the flesh of cassava cultivar "CARI-555". The results presented that the moisture content of the flesh of CARI-555 showed strong significant negative relationships ($p<0.05$) with ash content (Fig. 2a) and the fat content of the flesh (Fig. 2b).

The observations of Somendrika *et al.*[10] in proximate composition analysis of Sri Lankan cassava varity Kirikawadi showed a significant negative relationship between moisture content of the flesh and fat content of the flesh in Kirikawadi roots. The results were tallied with the observations of the current results.

The fat content in the flesh was correlated positively and significantly ($p<0.05$) with the fat content of peel (Fig. 2c).

CONCLUSION

The root flesh contain significantly high amount of carbohydrates than the peel where the peel contain

significantly high amount of moisture, ash, crude protein and crude fibre than the root flesh. A negative correlation was significantly exist in between the moisture, fat and ash content of flesh. The fat content of the flesh was correlated positively and significantly with the fat content of the peel.

SIGNIFICANCE STATEMENTS

- Cassava (*Manihot esculenta*) which is considered as the 3rd most important food source in tropics is a cheap and reliable food source for people in developing countries
- It is considered as one of major metabolic sources of energy for millions in the tropics and also an important raw material for industrial uses
- The recent records of Sri Lanka have shown that, the estimated annual production of cassava in year 2014 is 302,767 Mt and the area of land under cultivation of cassava is 23,970 ha
- In 1988 the Department of Agriculture in Sri Lanka released its 1st cassava cultivar, CARI-555, which is with very high farmer acceptance due to desirable characters like good plant type, high yield potential and good culinary qualities
- In order to characterize the proximate composition, to increase the utilization as food and the industrial utilization of selected cassava cultivar, the proximate (moisture, ash, total fat, crude fibre, crude protein and carbohydrate) in the peel and the flesh of cassava cultivar "CARI-555" was analysed

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