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# FUNCTIONAL PROPERTIES OF FLOUR FROM FIVE DIFFERENT SRI LANKAN CASSAVA (*Mannihot esculenta*) CULTIVARS

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## Introduction

Cassava (*Mannihot esculenta*) is an important tuber crop and is one of the major sources of carbohydrate that fulfils the dietary requirements of low income families in Sri Lanka. Its physicochemical properties and high availability have made it interesting and challenging ingredient for the food industry. Cassava flour is used extensively in pharmaceutical and food industry because of its unique thickening properties, high purity, low cost and its ability to form clear viscous pastes. In food industry, it is processed into various pre gelatinized instant and convenience foods including gari, pupuru, and fermented cassava flour. It is used in processed baby foods as a filler material and binding agent in confectionary and biscuit industries because of its bland flavor. In Sri Lanka, cassava is cultivated mainly by resource limited farmers only for the starchy roots and Sri Lankans have not explored the potential of cassava in terms of product diversification rather than consumed as boiled or fried chips. Sri Lanka has a surplus production of cassava and it is an unexploited tuber crop while having high demand in both local and export market. Diversification of cassava in to value added products is a promising way to increase the demand and to create a path for resource limited farmers and medium scale entrepreneurs to enter into the local market. Thus, the present study is aimed at investigating the suitability of production of cassava flour from five Sri Lankan cassava cultivars to be used as a raw material in the food industry.

## Materials and Methods

Matured tubers of 'Suranimala', 'Swarna', 'Shani', 'MU-51' (var. Peradeniya), and 'Kirikawadi' cultivars of cassava were harvested from the fields of the Horticulture Crop Research and Development Institute, Gannoruwa, Peradeniya, Sri Lanka.

### *Flour Extraction*

Cassava tubers were cleaned and peeled. After peeling, they were grated and thoroughly mixed with water in the ratio of 1:1.25, allowed to standing in an open vessel for about 5 h at about 30 °C. Subsequently, they were dehydrated at 50 °C for 20 hours. Dehydrated cassava slices were ground and passed through sieves

(0.250mm) to obtain flour. The flour was placed in Poly-Nylon plastic vacuum bags and vacuum packed. Vacuum packed flour packages were stored in food processing laboratory at room temperature until further used [6].

*Moisture Content*

Moisture contents of flour samples were determined by the oven drying method (AOAC, 2012), by applying the gravimetric principle.

*Ash Content*

Ash contents of the flour samples were determined by using the dry ashing (AOAC, 2012), by applying the gravimetric principle.

*Water Holding Capacity (WHC)*

One gram of flour sample was mixed with 10 mL of distilled water and allowed to stand at room temperature (30±2 °C) for 30 minutes. Then sample was centrifuged for 30 minutes at 3000 rpm. The WHC was expressed as a percentage of grams of absorbed water to weight of the sample [5].

*Oil Holding Capacity (OHC)*

One gram of flour sample was mixed with 10 mL of refined soy bean oil and allowed to stand at room temperature (30±2 °C) for 30 minutes. Then sample was centrifuged for 30 minutes at 3000 rpm. The OHC was expressed as a percentage. The OHC was expressed as a percentage of grams of absorbed oil to weight of the sample [5].

*Water Solubility Index (WSI) and Swelling Power (SP)*

One gram of flour sample was dissolved with 10 mL of distilled water in a graduated centrifuged tube. The suspension was stirred just sufficiently and uniformly avoiding excessive speed since it might cause fragmentation of the starch granules. The slurry in the tube was heated at 85 °C in a thermostatically regulated temperature water bath for 30 minutes with constant gentle stirring. Then the tube was removed, wiped off the outside of the centrifuged tube and cooled to room temperature. Thereafter, it was centrifuged at 2200 rpm for 15 minutes. The supernatant was decanted into pre weighed moisture can. The solubility was determined by evaporating the supernatant in thermostatically controlled drying oven at 105 °C and weighing the residue. The sediment paste was weighed and swelling power was calculated as the equation given below [5].

$$\%\ \text{Solubility} = \frac{\text{Weight of soluble}}{\text{weight of sample}} \times 100$$

$$\text{Swelling Power} = \frac{\text{Weight of Sediment}}{\text{Sample wieght-Weight of soluble}}$$

*Gelatinization Temperature*

One gram of flour sample was weighed accurately in triplicate and transferred to 20 mL screw capped tubes. After adding 10 mL of water into each sample, the samples were heated slowly in a water bath until they formed a solid gel. At the completion of gel formation the respective temperature was measured and taken as gelatinization temperature [5].

*Least Gelation Concentration*
Flour dispersions of 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20% (W/V) were prepared in 5 mL of distilled water in test tubes and heated for one hour in boiling water (100 °C) bath. The heated dispersions were cooled rapidly under running tap water and then at 10±2 °C in a refrigerator for 2 hours. The least gelation concentration was determined from above concentrations when the sample in the inverted tube did not slip [5].

*Bulk Density*
Twenty grams of flour sample was poured through a short stemmed glass funnel into a 250 mL graduated glass cylinder and the volume occupied by the flour was read and the bulk density calculated in triplicate [5].

*Emulsion Activity and Stability*
One gram of flour sample was mixed with 5 mL of distilled water and 5 mL of soybean oil in a calibrated centrifuged tube. The emulsion was centrifuged at 3000 rpm for 5 minutes. The ratio of the height of emulsion layer to the height of the mixture was calculated as emulsion activity in percentage. The emulsion stability was determined after heating the emulsion contained in calibrated centrifuged tube at 80 °C for 30 minutes in a water bath. Cooling for 15 minutes was allowed under running tap water and centrifuged at 3000 rpm for 15 minutes. The percentage of ratio of the height of emulsified layer to the total height of the mixture was expressed as the emulsion stability [5].

*Statistical Analysis*
All experiments were done in triplicates. The Statistical Package for the Social Sciences (SPSS) version 16.0 package and Microsoft Office Excel 2007 were used in the statistical analyses. In order to compare the means, one way ANOVA was used. In statistical tests, p value < 0.05 was considered significant [5].

**Results and Discussion**
In the present study, flour types from five different Sri Lankan cassava cultivars were analyzed for physical and functional properties. The results are given in the Table 1.

**Table 1: Functional properties of flour from five different Sri Lankan cassava cultivars**

| | Cassava Cultivar | | | | |
|---|---|---|---|---|---|
| **Functional Property** | **Kirikawadi** | **MU 51** | **Swarna** | **Shani** | **Suranimala** |
| Moisture (%) | $6.56^a \pm 0.29$ | $4.45^b \pm 0.39$ | $7.78^c \pm 0.42$ | $5.35^d \pm 0.01$ | $6.49^a \pm 0.03$ |

| | | | | | |
|---|---|---|---|---|---|
| Ash (%) | $1.12^{a}\pm0.02$ | $1.34^{a}\pm0.11$ | $1.68^{b}\pm0.04$ | $1.23^{a}\pm0.08$ | $2.06^{c}\pm0.01$ |
| WHC (%) | $308.25^{a}\pm7.23$ | $275.18^{b}\pm12.99$ | $211.09^{c}\pm18.92$ | $261.29^{b,d,}\pm11.16$ | $159.72^{e}\pm5.61$ |
| OHC (%) | $110.90^{a}\pm0.83$ | $98.82^{a,c}\pm3.01$ | $120.65^{a,b,d}\pm8.55$ | $107.53^{a}\pm12.93$ | $97.62^{a,c,f}\pm5.44$ |
| WSI (%) | $2.72^{a}\pm0.19$ | $1.91^{a}\pm0.25$ | $2.17^{a}\pm0.08$ | $2.97^{a}\pm0.01$ | $4.64^{b}\pm1.44$ |
| SP (%) | $6.79^{a}\pm0.1$ | $16.43^{b}\pm0.99$ | $8.09^{c}\pm0.42$ | $10.80^{d,f}\pm0.33$ | $10.40^{e,f}\pm0.39$ |
| LGC (%) | $10^{a}\%$ | $8^{a}\%$ | $8^{a}\%$ | $4^{b}\%$ | $6^{c}\%$ |
| GT (°C) | $68.33^{a}\pm0.58$ | $68.33^{a}\pm0.58$ | $68.00^{a}\pm1.00$ | $68.33^{a}\pm0.57$ | $68.61^{a}\pm0.58$ |
| BD(g/mL) | $2.03^{a}\pm1.15$ | $2.17^{a}\pm2.89$ | $2.08^{a}\pm0.57$ | $2.13^{a}\pm 2.12$ | $2.28^{a}\pm0.71$ |
| EA (%) | $52.54^{a}\pm0.54$ | $62.37^{a,b}\pm5.04$ | $53.53^{a}\pm0.01$ | $44.62^{a,c}\pm8.56$ | $45.87^{a,c,d}\pm2.86$ |
| ES (%) | $45.96^{a}\pm1.14$ | $48.953^{a}\pm0.61$ | $46.96^{a}\pm0.81$ | $46.94^{a}\pm0.54$ | $44.66^{a}\pm2.86$ |

WHC - Water Holding Capacity, OHC -Oil Holding Capacity, WSI -Water Solubility Index, SP -Swelling Power, LGC -Least Gelation Concentration, GT -Gelatinization Temperature, BD - Bulk Density, EA - Emulsion Activity, ES – Emulsion Stability

Values are expressed as "Mean±SD" of three independent determinations.

Different superscripts in a raw represent significantly different samples.

There was no significant difference between the moisture contents of flour from Kirikawadi and Suranimala cultivars *(P>0.05)* while all other cultivars had significant differences in moisture contents of flour. They were ranged between 4.45±0.39% to 7.78±0.42%. Flour from MU 51 cultivar had the lowest moisture content while flour from Swarna cultivar had the highest moisture content. Maximum ash content of 2.06±0.01% was reported in Suranimala cultivar while Kirikawadi cultivar had the minimum ash content. Ash contents of flour from five cultivars had significant differences between them except between Kirikawadi and MU 51 cultivars *(P>0.05)*, Kirikawadi and Shani cultivars *(P>0.05)* and MU 51 and Shani cultivars *(P>0.05)*. Highest WHC of 308.25±7.23% and OHC of 120.65±8.55 were found in flour from Kirikawadi cultivar and Swarna cultivar respectively. The lowest water holding and oil holding capacities were found in flour from Suranimala cultivar. In case of WHC of flour, there was no significant difference between MU 51 and Shani cultivars *(P>0.05)* while all other had significant differences in their WHCs. Swarna cultivar had significant differences of OHC with MU 51 *(P<0.05)* and Suranimala *(P<0.05)* cultivars while all other cultivars did not show significant differences in OHCs. The differences in WHC can be attributed to their different protein fractions. Flour with high WHC can be used in formulation of foods such as sausages, processed cheese and bakery products. OHC is mainly due to the physical entrapment of oil by capillary attraction [3]. Moreover, the hydrophobicity of proteins plays a major role in fat absorption [4]. Among the flour, variations in OHCs might be partially different due to different proportions of nonpolar side chains of the amino acids on the surfaces of their protein molecules. High OHC of flour is potentially useful in flavor retention, improvement of palatability and extension of shelf life in meat products. The SP and WSI of cassava flour from different cultivars were ranged from 6.79±0.1% to 16.43±0.99% and 1.91±0.25% to 4.64±1.44% respectively. The WSI of Suranimala cultivar had significant differences between Kirikawadi *(P<0.05)*, MU 51 *(P<0.05)*, Swarna *(P<0.05)*, and Shani *(P<0.05)* cultivars. There was no significant difference between the SP of Shani and Suranimala cultivars (*P>0.05*) whereas all other cultivars had significant differences in SP values. SP and WSI provide evidence of the magnitude of the interaction between starch chains within both the amorphous and crystalline domains [1]. Higher WSI and SP at higher temperature have important role in determining textural, pasting and thickening properties of starch based preparations. Therefore, cassava flour from these cultivars show a high potential to be used for the applications similar to the above in the food industry. Gelation is an aggregation of denatured molecules and the least gelation concentration is defined as the lowest protein concentration at which gel remained in the inverted tube. Flour from Kirikawadi cultivar formed the gel at a higher concentration (10%) and flour from Shani cultivar formed gel rapidly at lowest concentration (4%). Shani and Suranimala cultivars had significant difference (*P<0.05*) in LGC between them and with other cultivars. The gelation capacity is attributable to the globulin fraction and have been suggested that this property would make the proteins useful in food systems, e.g., puddings and sauces which require thickening and gelling properties. GT of flour was ranged from 68±1.00 °C to 68.61±0.58 °C. High GT may be due to the high amylopectin content where the branches prevent the degree of association for gel formation [2]. The BDs of five flour types were ranged between 2.28±0.71 g/mL and 2.03±1.15 g/mL. High BDs indicates that it would serve as good thickeners in food preparations. There were no significant differences in GT or BD of five flour types. The EA and ES of five types of cassava flour were ranged between from 62.37±5.04% to 44.62±8.56% and 48.53±0.61% to 44.66±2.86% respectively. The MU 51 cultivar had significant difference in EA with Shani cultivar (*P<0.05*) and Suranimala cultivar (*P<0.05*) while other had no significant differences between them. These high EA and ES of cassava flour can be used as primary functional properties in foods such as salad dressings, frozen desserts and mayonnaise.

**Conclusions and Recommendations**

According to the present study, it can be concluded that there is an effect of cultivar on the functional properties of the cassava flour. Moreover, the flour from Kirikawadi, MU 51, Swarna, Shani and Suranimala cultivars can be used as raw materials in the food industry. The present findings revealed that the potential of extraction and utilization of flour from Sri Lankan cassava cultivars for its commercial applications in various food industries.

**References**

[1] I.P. Claver, H. Zhang, Q. Li, K. Zhu and H. Zhou, "Impact of the Soak and the Malt on the Physicochemical Properties of the Sorghum Starches". *International Journal of Molecular Sciences,* Vol.11, pp. 3002-3015, 2010

[2] T. Gaffa, Y. Yoshimoto, I. Hanashiro, O. Honda, S. Kawasaki and Y. Takeda, "Physicochemical properties and molecular structure of starches from millet

(Pennisetum typhoides) and sorghum (Sorghum bicolor L. Moench) cultivars in Nigeria". *Cereal Chemistry,* Vol. 81, pp.255-260, 2004

[3] J.E. Kinsella, "Functional properties of protein in food- A survey". *Critical Review Food Science Nutrition*, Vol. 5, pp. 219, 1976

[4] L.P. Voutsinas and S. Nakai, "A simple turbidimetric method for determining the fat binding capacity of proteins". *Journal of Agricultural and Food Chemistry*, Vol. 31, pp. 58-61, 1983

[5] C. Suresh and Samsher, "Assessment of functional properties of different flours". *African Journal of Agricultural and Food Chemistry,* Vol. 31, pp. 58-61,1983

[6] S. Samad, H. Rasulu, Hasbullah and S. Hasan, "Chemical properties of high quality cassava flour (HQCF) from several varities of cassava". *Pakistan Journal of Nutrition*, Vol.17, pp.615-621, 2018