

**Characterization of starches from underutilized tubers
and yams and development of modified starches from
sweet potatoes (*Ipomea batatas* (L) Lam)**



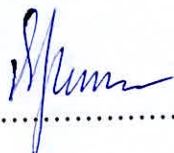
by

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award of the Degree of Doctor of Philosophy in Food Science in 2014**

Certification of supervisors

I certify that the candidate has incorporated all the corrections, additions and amendments recommended by the examiners.

A handwritten signature in blue ink, appearing to read 'K. K. D. S. Ranaweera', is written over a horizontal dotted line.

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DECLARATION

The work described in this thesis was carried out by me under the supervision of Professor K.K.D.S.Ranaweera, Director, Bandaranaike Memorial Ayurvedha Research Institute and Senior Lecturer, Department of Food Science and Technology, University of Sri Jayewardenepura, Emerites Professor Arthur Bamunuarachchi, University of Sri Jayewardenepura, Sri Lanka and Professor Anil Gunaratne, Senior Lecturer, Faculty of Agricultural Sciences, Sabaragamuwa University of Sri Lanka, Belihuloya. The report on this has not been submitted in whole or in part to any University for another Degree/Diploma.



21/04/2015

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We certify that the above statement made by the candidate is true and that thesis is suitable for submission to the University for the purpose of evaluation.



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TABLE OF CONTENTS

CHAPTER 1	1
INTRODUCTION	1
CHAPTER 2	5
LITERATURE REVIEW.....	5
2.1 Root and tuber crops – production and consumption.....	5
2.2 Sweet potato in perspective.....	10
2.2.1 Morphology and transplantation.....	10
2.2.2 Harvesting, curing and storage of sweet potato.....	12
2.2.3 Nutritional value of sweet potato.....	13
2.3 Sweet potato starch and its properties.....	16
2.3.1 Starch extraction.....	16
2.3.2 Chemical composition of starch granules.....	16
2.3.3 Amylose and amylopectin.....	17
2.3.4 Granule structure and organization.....	18
2.3.5 Starch digestibility.....	18
2.3.6 Swelling and gelatinization.....	20
2.3.7 Gelatinization study by DSC.....	21
2.3.8 Starch pasting.....	22
2.3.9 Starch gelation and retrogradation.....	24
2.4 Modification of starch.....	24
2.4.1 Hydrothermal treatment (HMT).....	25
2.4.2 Hydroxypropylation of starch.....	26
CHAPTER 3	28
METHODOLOGY.....	28
3.1 Materials.....	28
3.2. Flour preparation.....	29
3.3. Starch extraction.....	29
3.4. Chemical composition analysis of flour/ starch samples.....	30
3.5. Estimation of crude phytochemicals in yams and <i>Xanthosoma</i> sp.....	31
3.5.1. Crude saponin determination.....	31

3.5.2. Crude flavonoid determination	31
3.5.3. Crude alkaloid determination.....	31
3.6. Morphology of starch granules.....	32
3.7. Trypsin inhibitory activity (TIA) of sweet potatoes.....	32
3.7.1 Reagent preparation	32
3.7.2 Analytical procedure.....	33
3.8. Swelling power (SP) and water soluble index (WSI).....	35
3.9. Total amylose content in starch granules	36
3.10. Digestibility of sweet potato.....	36
3.11. Gelatinization of starch	37
3.12. Retrogradation	37
3.13. Pasting properties	37
3.14. Starch modification	38
3.14.1. Heat – Moisture Treatment (HMT)	38
3.14.2. Hydroxypropylation.....	38
3.15. Syneresis of cooked starch after refrigeration and freeze – thaw.....	39
3.16. Formulation of vegetable soup mixture and analyzing the viscosity	40
3.17. Sensory analysis	40
3.18. Shelf life analysis of dehydrated soup mixture	41
3.19. Statistical analysis	41
CHAPTER 4	42
RESULTS AND DISCUSSION	42
4.1. Starch extractability.....	42
4.2. Chemical composition of flour samples	44
4.3. Mineral elements in tuber and root crops.....	47
4.4. Phytochemical composition in yams and <i>Xanthosoma</i> sp.....	49
4.5. Morphology of different starch granules.....	50
4.6. Total amylose content in sweet potato starch.....	54
4.7. Trypsin Inhibitor (TI) levels in sweet potatoes	55
4.8. Swelling Power (SP) and Water Soluble Index (WSI) of sweet potato starch.....	58
4.8.1. Heat – moisture treated (HMT) sweet potato starch.....	58
4.8.2. Hydroxypropylated sweet potato starch	61

4.9. Digestibility of sweet potato starch	63
4.9.1. Heat – moisture treated starch	63
4.9.2. Hydroxypropylated starch.....	69
4.10. Gelatinization and retrogradation	70
4.10.1 Gelatinization and retrogradation of native sweet potato starch.....	70
4.10.2. Gelatinization and retrogradation of hydroxypropylated starch	74
4.11. Pasting properties by RVA	78
4.11.1. Pasting properties of native starch	78
4.11.2. Pasting properties of hydroxypropylated starch	79
4.11.3. Pasting properties of heat moisture treated starch	81
4.12. Syneresis during refrigerated storage	83
4.12.1. Hydroxypropylated starch.....	83
4.12.2: Heat – moisture treated starch	85
4.13. Syneresis during freeze – thaw cycles.....	86
4.13.1. Hydroxypropylated starch.....	86
4.13.2. Heat – moisture treated starch	87
4.14. Viscosity analysis in the vegetable soup mixture with added starch	89
4.14.1. Hydroxypropylated starch.....	89
4.14.2. HMT sweet potato starch.....	90
4.15. Sensory analysis of the soup mixture	92
4.16. Analysis of the shelf life.....	93
CHAPTER 5	95
CONCLUSION	95
REFERENCES.....	97
APPENDIX – I.....	111
APPENDIX – II	114

LIST OF TABLES

Title	Page No.
Table 2.1: Root and tuber crop production in the world.....	6
Table 2.2: Energy values of tropical root crops (per 100 g of edible portion).....	7
Table 2.3: Production of root and tuber crops in developing countries in 1993....	9
Table 2.4: Production of Major Root crops in Sri Lanka.....	9
Table 2.5: Comprehensive utilization of sweet potato.....	11
Table 2.6: Pasting type of starches from different sources.....	22
Table 3.1: Reagent composition in extracted suspensions.....	34
Table 4.1: Moisture and starch extractability level in fresh tubers and roots.....	42
Table 4.2: Chemical composition of yams and <i>Xanthosoma</i>	44
Table 4.3: Chemical composition of sweet potatoes	46
Table 4.4: Mineral contents of yams, <i>Xanthosoma</i> sp and sweet potatoes.....	47
Table 4.5: Phytochemical Composition of yams and <i>Xanthosoma</i> sp.....	50
Table 4.6: Starch granular size and amylose: amylopectin in sweet potatoes.....	54
Table 4.7: Trypsin Inhibitory Activity of heated and unheated samples.....	56
Table 4.8: Changes in SP of different sweet potato starches after 6 hr HMT.....	69
Table 4.9: Variation of WSI in different sweet potato starches after 6 hr HMT...	62
Table 4.10: Digestibility, SP and WSI in native/ hydroxypropylated starch.....	63
Table 4.11: Digestibility changes in of sweet potato starches after HMT.....	66
Table 4.12: Retrogradation properties of sweet potato starches.....	71
Table 4.13: Gelatinization of native/ hydroxypropylated sweet potato starch.....	75
Table 4.14: Pasting properties of native starch.....	77
Table 4.15: Pasting properties of HMT starch.....	82

Table 4.16: Syneresis (%) of starch gels within four week refrigerated storage...	84
Table 4.17: Average ranks of sensory attributes for the developed formulas.....	92
Table 4.18: Total plate count (cfu/ g) within 6 month period.....	93

LIST OF FIGURES

Title	Page No.
Figure 1.1: Common yam and <i>Xanthosoma</i> sp in Sri Lanka.....	2
Figure 1.2: Locally Cultivated sweet potato varieties.....	3
Figure 3.1: Studied root and tuber crops.....	28
Figure 3.2: Formulated vegetable soup mixes with added starch.....	40
Figure 4.1: Starch granules of yams and <i>Xanthosoma</i> (LM view).....	51
Figure 4.2: Sweet potato starch granules (LM view).....	52
Figure 4.3: Sweet potato starch granules (SEM) view.....	53
Figure 4.4: Temperature – moisture effect on SP of sweet potato starch.....	59
Figure 4.5: Temperature – moisture effect on WSI of sweet potato starch.....	60
Figure 4.6: Digestibility of cultivars at varying moisture levels.....	65
Figure 4.7: Effect of temperature on digestibility in different cultivars.....	67
Figure 4.8: Digestibility at different levels of HMT for 6 hours.....	69
Figure 4.9: Gelatinization DSC curves of sweet potato starch.....	72
Figure 4.10: DSC curves of amylopectin retrogradation	73
Figure 4.11: DSC curves of native and chemically modified starch.....	77
Figure.4.12: RVA curves of native sweet potato starches.....	80
Figure 4.13: RVA curves of native and hydroxypropylated sweet potato starch...	81
Figure 4.14: RVA curve for HMT treated starch.....	83
Figure 4.15: Syneresis of HMT starch during refrigerated condition.....	85
Figure 4.16: Percentage syneresis during four freeze – thaw cycles.....	87
Figure 4.17: Syneresis of HMT starch during frozen storage condition.....	88

Figure: 4.18. Viscosity change in the soup mixtures with starch additives.....	89
Figure: 4.19. Viscosity change due to added starch.....	91
Figure 4.20: Moisture level in packed mixture for 6 months period.....	94

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LIST OF ABBREVIATIONS

ANOVA – Analysis of variance

FAO – Food and Agricultural Organization

HMT – Heat – moisture treatment

HP – Hydroxypropylation

SP – Swelling Power

TI – Trypsin Inhibitor

TIA – Trypsin Inhibitor Activity

WSI – Water Soluble Index

NMR – Nuclear Magnetic Resonance

FAC – Food and Agriculture Committee

Characterization of starches from underutilized tubers and yams and development of modified starches from sweet potatoes (*Ipomea batatas* (L) Lam)

Suraji Arunika Senanayake

ABSTRACT

A study was carried out to analyze the potential application of starches obtained from underutilized root and tuber crops in food processing industry. Data obtained for physicochemical and functional properties of native and modified starches from nine different cultivars of root and tuber crops (*Dioscorea alata*, *Dioscorea esculenta*, *Xanthosoma sagittifolium* and *Ipomea batatas* (L) Lam) were determined in triplicated samples and data were analysed using MINITAB ver 14. Considering the level of starch extractability, starches from five different cultivars of sweet potatoes (*Ipomea batatas* (L) Lam) were analysed further to improve the functional characteristics. Significant levels of starch, proteins and mineral elements (Fe, Mg, Zn and Ca) were present in yams and *Xanthosoma*, while comparably high levels of crude fibre, resistant starch and potassium were observed with high amount of starch extractability in sweet potatoes.

Swelling power, water solubility and digestibility were greatly increased in the native starches due to physical and chemical modifications. Hydrothermal modification with more than 20% moisture and temperature around 85 °C has a positive impact on swelling, water solubility and digestibility. Physically modified starch had low granular break down (BD) and high set back (SB) during cooking and make more stable gels. Hydroxypropylated starches show reduced enthalpies for gelatinization and retrogradation for differential scanning calorimetry (DSC) studies, while the native

forms show a significantly high level ($p < 0.05$) of peak viscosity and cold paste viscosity in pasting profiles. Syneresis studies of hydroxypropylated sweet potato starch gels (7%/db) show significantly low level of water loss in comparison to native and physically modified starches during refrigerated and frozen storage. Increased level of soup viscosity was shown compared to corn starch, native and hydroxypropylated starch, in physically modified starches.

Sensory analysis showed a higher level of preference for physically modified sweet potato starch added vegetable soup mixers (Pallepola and Malaysian) compared to corn starch, and the overall study indicate a greater potential in application of physically modified sweet potato starch as a substitute thickener and chemically modified starch as a stabilizing starch source during frozen and cold storage for a wide range of food products in the industry.

CHAPTER 1

INTRODUCTION

Roots and tuber crops are efficient solar energy transferors and are used as rich sources of starch throughout the world. They can be cultivated under less favourable conditions with minimum amount of agricultural inputs. These crops are grown in the tropical regions and are consumed as primary, secondary or supplementary staples. Root and tuber crops can be consumed boiled, roasted, fried or cooked. The commonly cultivated root and tuber crops in Sri Lanka are potatoes, sweet potatoes, cassava, cocoyam, *Dioscorea*, innala, ginger and turmeric. In this study underutilized though commonly available seasonal and non – seasonal root and tuber crops were selected and their proximate composition and physico chemical characteristics were analyzed. Based on the starch extractability of the selected cultivars, root crops were categorized into starch sources for further analysis and modification. The main objectives of the present study were,

Dioscorea alata and *Dioscorea esculenta* are the two main yam species commonly found in Sri Lanka while *Xanthosoma sagittifolium* (Kiriala) species is also commonly consumed since it is available throughout the year. Although *Dioscorea* (Family: Dioscoreaceae) is a genus consisting of 630 identified species , nearly about 40 *Dioscorea* varieties are grown in Sri Lanka (Jayasuriya, 1995). The base of the *Dioscorea esculenta* (Kukulala) stem contains a large number of tubers which are generally ovoid and cylindrical (Fig1.1) Kukulala is widely cultivated in Sri Lanka, due to its flavour and short maturity period. The fleshy underground stem of *Dioscorea alata* (Rajala and Hingurala) contains only a single large tuber per vine. *Dioscorea* are