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Analysing Indian Yam (Dioscorea) Varieties Based on Starch Viscosity: A Comparative Scientific Study

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Abstract

Background: *yam (dioscoreae) stands as a crucial crop, rich in fiber and starch, widely utilized in food and pharmaceutical industries. This research delved into three indian yam cultivars: potato, elephant yam, and cassava.*

Aim: *the aim of the present study is to isolate the starches from potato, elephant yam, and cassava and their viscosity properties.*

Objective: *to isolate starches from potato, elephant and cassava starch by using alkaline extraction. To evaluate the viscosity properties of the isolated starches using brookfield viscometer.*

Methods and methodology: *The three different yams cultivars viz., potato, cassava and elephant yam were processed in the present investigation for isolation of starch and % yield of obtained starch was compared. The viscosity of the yam starches of three different varieties was studied by the brookfield viscometer. The viscosity, determined by using standard type of viscometer at 100 rpm, of the starch samples of the different varieties. Potato starch exhibited the highest viscosity, trailed by cassava and elephant yam. A comparative analysis of viscosity, depicted in the plot of % starch solution versus viscosity highlighted slight differences among varieties.*

Results: *Starch isolation via alkali extraction method was followed by characterization for viscosity using a brookfield viscometer. Starch yield ranged from 81% to 90% on a fresh weight basis. Potato exhibited the highest starch yield at 90%, while elephant yam showed the lowest at 81%, and cassava stood at 85%. For viscosity analysis, gruels were prepared from 1%, 2%, 3%, and 4% starch solutions in distilled water. After boiling and cooling, viscosity was measured using a standard viscometer at 100 rpm, expressed in centipoise. Results indicated a clear influence of processing pre-treatment on starch properties. Viscosity varied among cultivars and was concentration-dependent. Potato starch solution demonstrated the highest viscosity at 21.6 centipoise, followed by cassava at 18.5 centipoise, and elephant yam at 16.5 centipoise, all measured at 4% concentration.*

Conclusion: *These findings underscore the distinct rheological characteristics of starch from different yam cultivars and highlight the potential for tailored applications in various industries.*

Keywords: *yam starch; alkali extraction; viscosity; centipoise; brook-field viscometer.*

INTRODUCTION

Yam (Dioscorea), a vital tropical tuber crop, thrives across Africa, Asia, and South America, bolstering food security for millions in tropical and subtropical regions. Renowned for its rich carbohydrate and fiber content, yam serves as a cornerstone in the diets of many. Moreover, it holds cultural significance, with its products often employed as traditional remedies, such as addressing impotence in certain Japanese island communities. In India, a plethora of rice varieties enrich the culinary landscape, including Potato, Cassava, Elephant yam, Water yam, Chinese yam, and White Yam. These diverse cultivars offer a spectrum of flavors and nutritional benefits, contributing to the dietary diversity of the region.The investigation into Potato, Cassava, and Elephant yam, among others, underscores the importance of understanding the starch dynamics within these crops. Starch stands as the primary dietary source of carbohydrates, prevalent in roots, tubers, grains, legumes, fruits, and vegetables. It constitutes a polymer of glucose, intricately linked by α-D-(1-4) and/or α -D-(1-6) glycoside bonds.

Notably, the starch granule mass manifests a nuanced composition: approximately 70% amorphous regions comprising amylose and amylopectin branching points, while the remaining 30% crystalline component primarily comprises the outer chains of amylopectin. This distribution delineates the structural integrity and functional properties of starch, dictating its diverse applications in culinary and industrial realms. The amorphous regions, rich in amylose and amylopectin branching points, lend starch its viscoelastic properties, facilitating gel formation and texture modulation in food systems. Meanwhile, the crystalline fraction, dominated by the outer chains of amylopectin, contributes to the rigidity and stability of starch-based matrices. Understanding these proportions and compositions are crucial for optimizing the utilization of starch in various applications. Whether in food formulation, pharmaceuticals, or industrial processes, the intricate balance between amorphous and crystalline regions determines the functionality and performance of starch-based materials. As research delves deeper into the complexities of starch structure and behavior, opportunities emerge for innovation and enhancement in crop breeding, food processing, and product development. By harnessing the inherent diversity of starch in botanical sources like yam and rice cultivars, we can address nutritional needs, promote agricultural sustainability, and foster culinary creativity across global cuisines.

MATERIALS AND METHODS

Yams

Three cultivars of yams (Dioscoreae) Viz., Potato, Cassava and Elephant yam were procured from local market of Cuddalore. The yams were cleaned, ground in mixture grinder and stored properly at room temperature prior to their use in actual experiment.

Figure 1 showing Isolation of Starch (Alkali Extraction Method) - Flow sheet

100 gm. yams

(Disperse in 1500 ml distilled water adjust to p^H 10 with 1n NaoH; stand for 1hr with moderate stirring)

Supernatant
(Processed for protein extraction)

Residue
(Extracted With 1 Liter D.W. for 24 hrs at $4^{0C)}$
Centrifuge at 10000 rpm for 30min

|

Residue (Extracted with 1 liter 2% Nacl, for 24hrs, at 4^0C)

|

Centrifuge at 10000 rpm for 30min and Discard supernatant.

|

Residue (Extracted with 300 ml of 0.1N NaOH, for 48hrs, at 4^0C)

|

Centrifuge at 10000 rpm for 30min and Discard supernatant. Collect white starch layer

|

Re suspend in 80% ethanol (Blended for 1min using stirrer)

|

Heating on water bath at 80^0C for 1hr.

|

Settle for 4 hr at 4^0C and discard supernatant

|

Residue

|

Freeze Dehydrate

|

Starch

Viscosity of starch by Brookfield Viscometer

A Brookfield Viscometer assessed viscosity, measuring starch solutions (1%, 2%, 3%, and 4%) derived from Potato, Cassava, and Elephant yam starch varieties blended with distilled water. Solutions were boiled for 20 minutes, cooled to room temperature (30°C), and viscosity readings obtained at 100 rpm in Centipoise. Stirring occurred intermittently during heating and cooling phases to ensure uniform consistency.

RESULTS

Isolation of Starch

The three different yams cultivars viz., Potato, Cassava and Elephant yam were processed in the present investigation for isolation of Starch and % yield of obtained starch was compared and shown in Table 1.

Table 1: % Yield of starch from Yam Flour

S.NO	VARIETY OF YAMS	YEILD OF STARCH (%)
1.	Potato	89%
2.	Cassava	85%
3.	Elephant yam	80%

The table 1 Indicates the % yield of starch is highest for Potato (89%) followed by Cassava (85%) and Elephant yam (80%). The starch yield found directly correlated to thedry matter contents of the starch.

Viscosity of starch The viscosity of the yam starches of three different varieties was studied by the Brookfield Viscometer. The viscosity, determined by using standard type of viscometer at 100 rpm, of the starch samples of the different varieties is shown in the Table 2.

Potato starch exhibited the highest viscosity, trailed by Cassava and Elephant yam. A comparative analysis of viscosity, depicted in the plot of % starch solution versus viscosity (Fig.1), highlighted slight differences among varieties. Processing pretreatment inevitably altered starch characteristics. Variances in carbohydrate, dietary fiber contents, and starch properties across different varieties likely contributed to these distinctions. There is change in the physical state of the starch occurring as a function of temperature and water content. Also, the degree gelatinization considerably affects the rheological properties of the dried product.

Table 2: Viscosity of Starch Solution by Brookfield Viscometer

S.NO	VARIETY OFYAM STARCH	VISCOSITY (Centipoise)			
		1% solution	2% solution	3% solution	4% solution
1.	Potato	3.5	9.74	16.54	21.5
2.	Cassava	3.0	8.56	12.35	18.5
3.	Elephant Yam	2.0	7.98	11.85	16.5

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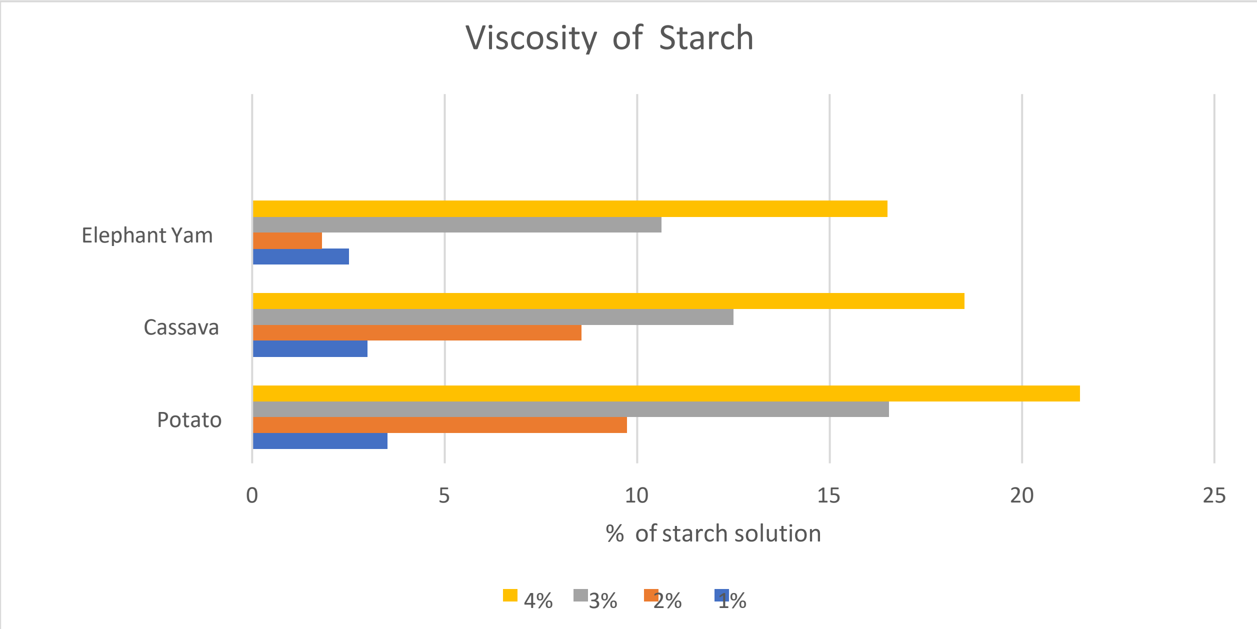
Fig. 2: Comparison by Viscosity values at different concentrations.



Viscosity of the gruels prepared from the different types of starch, to a large extentcan be attributed to the starch in the sample. In the manufacture of the food aimed at supplying a substantial amount of nutrient such as weaning and supplementary foods,it is desirable to include materials that do not form highly viscous pastes at low solids concentrations.

DISCUSSION AND LIMITATIONS

The investigation into starch isolation and viscosity assessment across three yam cultivars—Potato, Cassava, and Elephant yam—revealed significant variations in starch yield and rheological properties. The starch yield, with Potato exhibiting the highest at 89%, followed by Cassava at 85% and Elephant yam at 80%, underscores the influence of varietal differences and processing methods on starch extraction efficiency. These variations align with differences in dry matter content, reflecting the inherent diversity in starch composition among yam varieties.Viscosity measurements using a Brookfield Viscometer illustrated distinct rheological profiles among the starch samples. Potato starch exhibited the highest viscosity across all concentrations tested, followed by Cassava and Elephant yam. This differential viscosity can be attributed to inherent differences in starch structure, amylose-amylopectin ratio, and granule morphology among the cultivars. Additionally, processing pretreatments, such as heating and cooling, altered the physical state and gelatinization properties of starch, influencing its viscosity.However, this study is not without limitations. Firstly, the investigation focused solely on three yam cultivars, limiting the generalizability of the findings to other yam varieties or starch sources. Secondly, while the Brookfield Viscometer provides valuable insights into starch viscosity, it does not capture other rheological properties such as shear thinning behavior or viscoelasticity, which are relevant in many food and industrial applications. Moreover, the study did not delve into the molecular-level characterization of starch, such as amylose content, chain length distribution, or lipid composition, which can significantly influence starch functionality. Additionally, the study did not explore the effect of processing parameters, such as temperature and time, on starch properties comprehensively. Future research could address these limitations to provide a more comprehensive understanding of starch behavior and its implications in various applications.

CONCLUSIONS

Variation in starch yield and properties among three rice cultivars was evident, with starch yield ranging from 80% to 89%. Processing pretreatments notably altered starch characteristics, impacting viscosity. Viscosity varied proportionally to starch concentration, with Potato starch displaying the highest viscosity at 21.5

Centipoise, followed by Cassava at 18.5 Centipoise, and Elephant Yam at 16.5 Centipoise at 4% concentration. Pasting attributes were influenced by amylose and lipid content, as well as amylopectin branch chain-length distribution. Amylopectin facilitated starch granule swelling and pasting, while amylose and lipids hindered it. Moreover, amylopectin chain-length and amylose molecular size synergistically affected starch paste viscosity. Interactions between starch and other components present naturally or added as additives also played a role in pasting behavior. These findings underscore the complex interplay of various factors in determining the functional properties of starch, crucial for understanding its suitability in diverse applications.

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