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Research Article

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Physicochemical properties of starches from *Scleroderma citrinum* and *Pleurotus ostreatus*

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Abstract Starches isolated from *Scleroderma citrinum* (SC) and *Pleurotus ostreatus* (PO) were investigated using physical and chemical tests. Total starch content was higher in SC (89.41 %) than PO (75.00 %). Amylose content was also higher in SC (38.50 %) than PO (21.70 %), while amylopectin, moisture and ash contents were higher in PO than SC respectively. Gelatinization temperature was 70 ^{o}C for SC and 80 ^{o}C for PO. Dextrinization of the starch samples occurred between 150-180 ^{o}C and 120-150 ^{o}C for SC and PO respectively. Generally, these starches could have numerous applications in the non –food industry.

Keywords *Scleroderma citrinum*, *Pleurotus ostreatus*, amylose, amylopectin, dextrin

Introduction

Starches extracted from different botanical origins have played important roles in the food industries. They are used as a thickener, in snacks, gravies, sauces, muffins, etc. Also, they find application in cosmetics, paper coatings, laundry and biofilms production [1]. These starches have diverse physicochemical and functional properties which are influenced by their content of amylose and amylopectin as well as the structure of the amylopectin. Properties such as paste viscosity, α- amylase digestibility, gelatinization are affected by the amylose content of starch while amylopectin affects starch gelatinization and retrogradation properties [2]. Constraints such as insolubility, retrogradation, instability of gels and paste to varying temperatures, pH and shears have restricted their industrial applications; therefore the search for starches with better functional properties becomes imperative.

Pleurotus ostreatus (oyster mushroom, Family *Pleurotacaceae*) is a lignocellulose loving fungus which grows naturally in temperate and tropical forest on dead and decaying wood logs or decaying organic matter. They are easily recognised due to their peculiar morphology with an oyster shaped- cap. They are widely used as food for humans and have numerous medicinal values, including lowering of blood pressure, antitumor, antiviral, antidiabetic, antioxidant, anticancer, antiimmunomodulatory properties etc. These beneficial effects are due to their rich content of phytocompounds [3-8]. *Scleroderma citrinum* (earthballs or pigskin poison puffball, Family *Sclerodermataceae)* occurs as an ectomycorrhizal associates on woods, grasses or as saprophytes in soil. It is considered inedible and poisonous, and may cause gastrointestinal distress in humans if consumed [9].

Pleurotus ostreatus and *Scleroderma citrinum* grow abundantly in the South – South region of Nigeria, particularly during the rainy seasons. However, there are no studies on the properties of starches from these fungi. We report in this work, the preliminary physicochemical properties of starches isolated from both fungi with a view to providing information about their utilization, particularly for industrial use.

Materials and Methods

Collection

Earthball (*Scleroderma citritum*) and oyster mushroom (*Pleurotus ostreatus*) were collected from a farmland in Ibiono local government area, Akwa Ibom State, Nigeria, and identified using standard methods. The samples were

washed with distilled water containing 0.02 % sodium disulphite, cut into pieces, dried at 40-50 ^{o}C and ground to obtain a homogenous flour.

Extraction of starch from samples

Sample flours (80 g) were soaked in distilled water for 30 mins, strained through a muslin cloth and the filtrate left to settle for 6 hrs. This process was repeated thrice to ensure complete extraction. On completion of sedimentation, the supernatants were decanted to obtain the starch. This was resuspended in water and the separation process repeated. The resulting starch was oven dried at 60 ^{o}C for 12 hrs and stored in air-tight containers.

Preparation of soluble starch/moisture content

This was done in accordance with the method of Rolee and LeMestre [10] with some modifications. Briefly, 10 g of starch from each sample was placed in a conical flask and 50 mL of 95 % ethanol and 3.5 mL of 1.0 M HCl. Then, the content were cooled for 30mins, filtered and washed with distilled water until it gave a negative test with $AgNO_3$ solution. The filtrate (soluble starch) was thoroughly drained and dried at 35 ^{o}C for 48 hrs. To obtain its moisture content, 2.0 g of this soluble starch was sprayed in a thin layer over the bottom of weighing bottle, dried at 60 ^{o}C in an oven for 6 hrs. This was allowed to cool in a dessicator and reweighed. Its moisture content was calculated as the difference between the moisture content of the soluble starch and that of the oven dried soluble starch.

Evaluation of Physical properties

The pH, colour, texture, ash content, solubility of the soluble starch was evaluated using standard methods.

Determination of gelatinization characteristics

Soluble starch from each sample (3.0 g) was mixed with 60 mL of distilled water and heated in a water bath with constant stirring until it gelled. The temperature of the gel was noted as the gelatinization temperature. Thereafter, the viscosity of the gelled starch was determined relative to that of water by comparing the flow rate of the gelled starch (40 mL) through a 50 mL burette with that of distilled water.

Determination of amylose and amylopectin content of samples

This was done according to the modified method of Mojzoobi *et al* [11]. Briefly, 1.0 g of each sample was dispersed in 10mL of distilled water mixed with 20mL of 0.16M NaOH. The mixture was swirled gently until the suspension cleared. This was allowed to stand for 5mins, after which 4 mL of 5% NaOH was added and the pH adjusted to 7.0 with dilute HCl. The resulting solution was allowed to stand for a further 15 hrs. At the end of this period, the mixture was centrifuged (10,000 rpm) for 10 mins. The amylose supernatant was carefully decanted and quantified (V_t). 8.0 mL (V_a) of this supernatant was saturated with 4 mL of distilled butan-1-ol, stirred for 1 hr and allowed to stand for a further 2 hrs. This was then centrifuged at 5,000 rpm for 15 mins. The precipitated amylose-butanol complex was allowed to stand for 3hrs and the supernatant siphoned with a suction pump while the amylase precipitate was collected by filtration and dried at 80 ^{o}C in an oven. The amylase fraction was left to cool in a dessicator and weighed (W). Quantification of the amylose in each sample was done using the equation:

$$\% \text{ amylose} = (V_t \, x \, W \text{ x } 100) / V_a.$$

where V_t = total volume of supernatant; V_a = volume of amylase and W = weight of amylose obtained.

% amylopectin = 100 - % amylose.

Dextrinization of starch

10.0 g of each sample was mixed with 50 mL of 0.3 M HCl, stirred and allowed to age for 24 hrs. Then, the soaked starches were heated gradually to a maximum temperature of 180 ^{o}C with constant stirring until a sticky solution was obtained. This solution was left to cool at room temperature.

Results and Discussion

With the growing demand for starch due to increasing need for non food uses, the search for alternative sources of starch becomes more important. From Table 1, starch from SC was coarse and of medium granulation while starch from PO had a finer texture. Fine particle starch (< 180μm) have greater tendency of absorbing more water during hydration thereby enhancing its solubility and absorption capacity [12]. Our result suggests that starch from PS had better hydration and water absorption capacity than SC [13-14].

Table 1: Physicochemical properties of soluble starch from *Scleroderma citritum* and *Pleurotus ostreatus*

	Scleroderma citritum (SC)	***Pleurotus ostreatus (PO)***
Starch content (%DW)	89.41	75.00
Moisture content (%)	7.4	6.5
pH	8.2	7.3
Colour	Light brown	White
Texture	Coarse	Smooth
Ash (%)	0.5	0.2
Gelatinization temperature (^oC)	70	80
Relative viscosity of gel at room temperature (28^oC)	2.41	1.28
Relative viscosity of gel at gelatinization temperature (^oC)	1.4 (70^oC)	1.05 (80^oC)
Amylose content (%)	38.5	21.7
Amylopectin content (%)	61.5	78.3

Moisture content ranged between 6.5% for PS starch and 7.4% for SC starch. This were within acceptable range for starches [15] and lower than reports by Oladumoye *et al* [13]. SC starch had darker colour than PS starch, and was slightly alkaline. With regards to ash content, PO starch was lower (0.2%) than SC starch (0.5%). Our values are lower than reports for starches from improved bean (*Phaseolus vulgaris* L) varieties grown in East Africa [16]. High starch and low content of other components is indicative of high quality starch which is a desirable property.

Amylose content was higher in SC (38.5%) than PS (21.7%) , while amylopectin was higher in PS (78.3%) than SC (61.5%). Oladunmoye *et al* [13] reported lower values of 19.49% to 28.19% for cassava and wheat blends, while Kong *et al* [1] reported a range of 11.6% to 13.9% for cultivars of Amaranth starch. Also, Chen *et al* [17] reported an amylose content of 31.5% for starch from mung bean and 19.3% to 20.0% for various varieties of Chinese sweet potatoe. These were in agreement with our report for amylose in PS. In addition, higher amylose content (42.01%) was reported for maranta starch powder [18]. Amylose content of starches is important as it affects the pasting, gelatinisation, retrogradation and swelling properties of starches [19-20].

Peak gelatinization temperature of SC (70^oC) was lower than that of PS (80^oC). Gelatinization temperature of starches is affected by their botanical origin, amylose content and the structure of the amylopectin. Our values are in agreement with reports for starches from lotus (*Nelumbo nucifera*) rhizome, with gelatinization temperatures of 69^oC and 75^oC for the Meirenhong and Wawalian cultivars respectively [21]. Osundahunsi *et al* [22] reported peak gelatinization temperatures of 70.7^oC and 71.5^oC for red and white sweet potato cultivars. The higher gelatinization temperature of PS is suggestive of thermal stability and may be associated with its lower amylose content. This is in agreement with several reports [23]. The implication of the gelatinization characteristics of the starches is that PS requires higher energy to gel than SC. SC and PS starches formed odourless gels with variable viscosities. The viscosity of the gels (Table 1) were higher than that of water at both gelatinization and room temperature. The high viscosity of SC starch suggests its suitability for the production of adhesives.

Table 2: Optimal conditions for the dextrinization of starches from *Scleroderma citritum* and *Pleurotus ostreatus*

Sample	**Colour**	**Optimal roasting temperature (^oC)**	**Acid concentration (M)**	**Roasting time (min)**
Scleroderma citritum (SC)	Brown	180	0.3	90
Pleurotus ostreatus (PO)	White	150	0.3	90

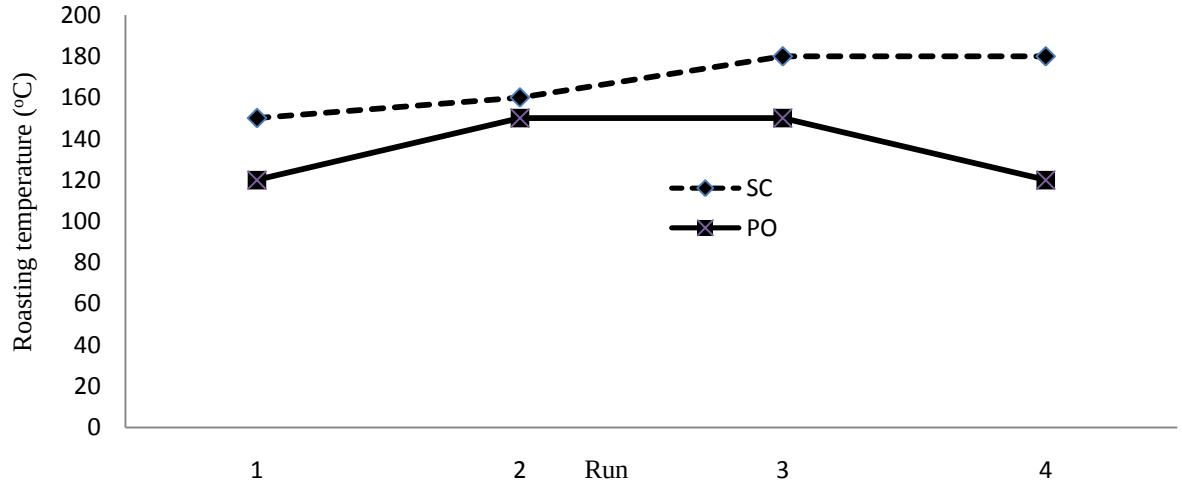

Figure 1: Effect of temperature on dextrinization of starch samples at a roasting time of 90 mins and an acid concentration of 0.3M

Variation of roasting temperature with run to determine the optimal condition for dextrinization of the starch samples is given in Fig.1. Results indicate that dextrinization occurred between 150-180 ^{o}C for SC and 120-150^{o}C for PS at a run time of 90 mins. Lower temperatures were found to be unfavourable. Dextrinization leads to structural changes in the starch and improves viscosity, increases solubility and reduces the sugar content thereby enhancing its non- food uses. As presented in Table 2, PS starch had a lower optimum dextrinization temperature than SC starch.

Conclusion

In this study, the physicochemical parameters, optimum gelatinization and dextrinization temperatures of starches from two lesser known sources *Scleroderma citritum* and *Pleurotus ostreatus* were evaluated. These samples were rich sources of starches, with variable amylose and amylopectin contents. Gelatinization temperatures were within range reported for other samples of botanical origin. Stable dextrins were formed by the samples. These result suggest the suitability of these starches for non –food applications.

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