ASSET Series B (2007) 6 (2): 143-150

ASSET
An
International
Journal

PROXIMATE COMPOSITION AND FUNCTIONAL PROPERTIES OF MODIFIED *MUCUNA SLOANEI* STARCH

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ABSTRACT

Proximate composition, water and oil absorption capacities, alkaline water retention capacity, gelation, effect of temperature and pH on solubility and swelling of unmodified, oxidized and acetylated starches were determined. Results revealed that solubility and swelling of starches of *Mucuna sloanei* seed were temperature and pH dependent. Acetylation of studied starches decreases solubility over temperature (60-90°C) and pH (2-14) range; decreases swelling over pH range but increases swelling over temperature range. Oxidation increases solubility and swelling over range of temperature and pH. Modification of the *Mucuna sloanei* starch resulted in loss of gelling properties.

Keywords: *Mucuna sloanei*, Starch, Composition, functional properties.

INTRODUCTION

Starches are the principal food reserve polysaccharides in the plant kingdom. They form the major source of carbohydrates in the human diet and are therefore of great economic importance. Starch from grains, tubers and roots have been consumed as food and animal feeds for centuries (Carioca *et a*l., 1996). Starches are added to food in the unmodified or modified form. Applications of starch in food industries are primarily governed by gelatinization, gelation, pasting, solubility, swelling, colour, and digestibility proper ties, depending on the end use (Deshpande *et al*., 1982).

Modified starches are used in the paper (surface sizing and paper coating), textile (as adhesive, stiffener, printing and polishing agents), soap, laundry, cosmetics and pharmaceutical industries, in fireproofing preparations, as explosive and fuel-binding agents, as flocculating agents for water treatment, and in the building industry (Kirby,1992). However, more than half of starch produced is used for the manufacturing of food and animal feeds products. Chemically modified starch form the main proportion being transformed into syrups and sugars. Generally, starch has to be modified by physical, chemical or enzymatic means in order to acquire particular properties. Cereal starches (particularly corn) are commercially produced and utilized in numerous ways, hence the properties have been investigated in great detail (Schoch and Maywald 1976). *M. sloanei* starches, on the other hand, are not commercially produced and consequently have been somewhat neglected. This is because *M. sloanei* is lesser known and has been primarily looked upon as a protein source rather than as a carbohydrate source, although carbohydrate is the major component of dry seeds (Yusuf *et al*., 2003). The present investigation was undertaken to obtain basic information on the physicochemical properties of unmodified, oxidized and acetylated *M. sloanei* starches.

MATERIALS AND METHODS

Collection of sample

M. sloanei seed were obtained at Ojere village near Abeokuta, Nigeria.The seeds were dehulled, sun-dried (30 ± 2^{o}C) and ground to pass through a 60-mesh sieve (British standard) to obtain fine powder, which was extracted with solvent to yield starch powder using Akintayo *et al*. (2000) method.

Acetylation and Oxidation of Starch

Twenty percent starch slurries (w/v) in distilled water were acetylated and oxidized as described by Sathe and Salunkhe (1981).

Proximate composition

Standard methods of the Association of Official Analytical Chemists (AOAC, 1984) were used for moisture, nitrogen, fat, and ash determinations.

Water and Oil Absorption Capacities

The water and oil absorption characteristics of the unmodified and modified starches were determined as described by Oshodi and Ekperigin (1989).

Solubility and Swelling

The solubility and swellings of the unmodified and modified starches were determined using Sathe and Salunkhe (1981) method. Effect of pH on solubility and swelling of starches was studied by preparing 1% (w/v) slurry in distilled water and pH adjusted to the desired value with 0.1 M HCl or 0.1 M NaOH. The slurries were then allowed to stand at room temperature for 30 minutes, centrifuged (2,500 rpm) and the solubility (%) and swelling (%) determined. Effect of temperature on solubility and swelling of starch were similarly studied by preparing 1% (w/v) starch slurry in distilled water for 30min at the desired temperature (60, 70, 80 and 90^{0}C).

Alkaline water retention capacity

M. sloanei flour and wheat flour was blended to give 0,10, 20, 30, 40, and 50% purified starch. 1g of each blend was introduced into a test-tube; 5ml of O.1M $NaHCO_3$ was added and mixed for 30 sec in a vari-whirl mixer. The samples were allowed to stand for 25min at room temperature, centrifuged at 2,000rpm for 15min. and drained for 10min. The test-tubes with their contents were weighed and the alkaline water retention was calculated.

Gelation

The least gelation concentrations of the unmodified and modified *M. sloanei* starches were determined according to the methods of Coffman and Grarcia (1977).

RESULTS AND DISCUSSION

Results of the proximate composition of unmodified, oxidized and acetylated *M. sloanei* starches are presented in Table 1.The yields of unmodified, oxidized and acetylated starches were 41.92, 90.68 and 96.01% respectively. The yield is similar to that of lima bean starche reported by Akintayo *et al.* (2000). The low protein content of *M. sloanei* indicated the level of purity of starch.

Water and oil absorption capacities of unmodified *M. sloanei* starch are relatively higher than oxidized and acetylated starches (Table 2). That is oxidation and acetylation decreased the water and oil absorption capacities of the starch studied, but more affected by acetylation. This observation is similar to results obtained for lima bean starches (Akintayo *et al*., 2000) but contrary to the results of Sathe and Salunkhe (1981) which showed that modification did not affect both oil and water absorption capacities of the Great Northern bean starch.

Table 3 showed a decrease in alkaline water retention capacities of oxidized, acetylated and unmodified *M. sloanei* starches. On comparism, the acetylated starch had higher alkaline water retention capacity followed by oxidized starch, while the unmodified starch had the lowest. The increased alkaline water retention capacity of the modified starches may be due to the breaking of the glycosidic bonds and formation of a large number of end aldehyde groups in the starch fractions (Carioca *et al*., 1996).

Gelation studies shown a stable gels at concentration of 6, 10, and 12% (w/v) for unmodified, oxidized and acetylated starches, respectively (Table 4). This means that both acetylation and oxidation led to loss of gelling properties of *M. sloanei* starch. This may be due to the presence of acetyl groups in the starch molecules that open the structure of the starch while carboxyl groups are introduced into the starch on oxidation. Also, the oxidation and carboxyl groups introduced are heavier than the hydroxyl groups that they replace in the amylose component of starch and these groups sterically interfare with the tendency of the amylose part to associate and form gel, hence the loss in gelling ability on modification of the *M. sloanei* starch.

The greater molecular degradation of starch (due to hypochlorite treatment under alkaline conditions) occurring during oxidation leading to higher fluidity of the oxidized starch may be responsible for the higher least concentration endpoint (LCE) for oxidized starch at 10%(w/v) compared to LCE of 12%(w/v) observed for acetylated starch.

Solubility of unmodified, oxidized and acetylated starch increases with increase in temperature (Fig.1) Acetylation reduces the solubility of starch with temperature while oxidation increases the solubility of starch.

The increased solubility of oxidized *M. sloanei* starch observed in this study is comparable to that of lima bean starch (Akintayo, *et al.*, 2000), Great Northern bean starch (Sathe and Salunkhe, 1981) and black gram starch (Deshpande *et al.*, 1982). Hypochlorite oxidation is known to weaken starch granules (Schoch and Maywald,1976) which may lead to the oxidized starch being more soluble than native starch.

The solubility of starches depends on the pH (Fig 2). Unmodified and oxidized *M. sloanei* starches have their highest and lowest solubility at pH 4 and 8, respectively.

Generally, oxidized starch has improved solubility in the acidic and alkaline regions (Fig. 2). This may have been due to their enhanced hydrophilic character and partial hydrolysis at acidic region (pH 4) and partial gelatinization at alkaline region (pH 8). At pH 12 and 14, modification has no effect on the solubility of *M. sloanei* starch (Fig. 2) The effect of temperature on swelling of Mucuna sloanei starches is presented in Fig. 3. Acetylation and oxidation caused increase in swelling except at 90^0C where swelling of acetylated starch was less than that of unmodified starch. Acetylation and oxidation of starches studied causes no fragmentation of molecules and more accessible intermicellar areas interfare with the side by side association or retro gradation, leading to products of high viscosity or swelling (Pomeranz, 1971). The result is in agreement with that observed for Great Northern bean starch by (Sathe and Salunkhe, 1981) and lima bean starches (Akintayo, *et. al.*, 2000). Acetylation and oxidation however reduced swelling of *M. sloanei* starch over the pH range 2-14 compared to that of the unmodified starch (Fig. 4). The molecular degradation of the starch molecules on modification probably explains the decreased swelling observed through these pH rages. It appears that swelling of starch granules was influenced more by temperature than pH.

Table 1: Proximate composition of *Mucuna sloanei* starches

Parameter (%)	Unmodified	Oxidized	Acetylated
Yield	41.92 ± 1.08	90.68 ±2.09	96.01 ± 2.17
Moisture	3.09 ± 0.51	4.11 ± 0.65	3.61 ± 0.63
Protein	0.51 ± 0.05	0.32 ± 0.06	0.44 ± 0.07
Fat	0.72 ± 0.02	-	-
Ash	0.38 ± 0.01	-	-

All values are shown as means of three replicates ± SD

Table 2: Water and oil absorption capacities of *Mucuna sloanei* starches

	Unmodified	Oxidized	Acetylated
Water absorption capacity (%)	3.25 ± 0.11	2.81 ± 0.10	2.09 ±0.16
Oil absorption capacity (%)	4.86 ± 0.23	3.68 ± 0.26	3.44 ± 0.19

All values are shown as means of three replicates ± SD

Table 3: Alkaline water Retention capacity (AWRC) of unmodified, oxidized and acetylated *Mucuna sloanei* starches

Starch and Wheat flour blend		AWRC (g/g)		
Starch (%)	Wheat flour (%)	Unmodified	Oxidized	Acetylated
100	0	1.09 ±0.02	2.38 ± 0.03	3.40 ± 0.03
90	10	1.08 ± 0.01	2.23 ± 0.02	3.10 ± 0.02
80	20	1.01 ± 0.01	2.16 ± 0.03	2.93 ± 0.03
70	30	0.98 ± 0.01	2.07 ± 0.02	2.51 ± 0.02
60	40	0.91 ± 0.02	2.00 ± 0.01	2.22 ± 0.02
50	50	0.86 ± 0.01	1.99 ± 0.02	2.00 ± 0.01

All values are shown as means of three replicates ± SD

Table 4: Effect of modification on the gelation of *Mucuna sloanei* starches

Concentration (% w/v)	Unmodified		Oxidized		Acetylated	
	Gelation	Remark	Gelation	Remark	Gelation	Remark
2	-	Liquid	-	Liquid	-	Liquid
4	-	Viscous	-	Liquid	-	Liquid
6	+	Gel (LCE)	-	Viscous	-	Liquid
8	+	Gel	-	Viscous	-	Viscous
10	+	Firm Gel	+	Gel (LCE)	-	Viscous
12	+	Firm Gel	+	Gel	+	Gel (LCE)
14	+	Solid Gel	+	Firm Gel	+	Gel
16	+	Solid Gel	+	Solid Gel	+	Firm Gel

(-) = no gelation, (+) = gelation, and LCE = Least concentration endpoint, which is the lowest starch concentration at which gel remained in the inverted tube.

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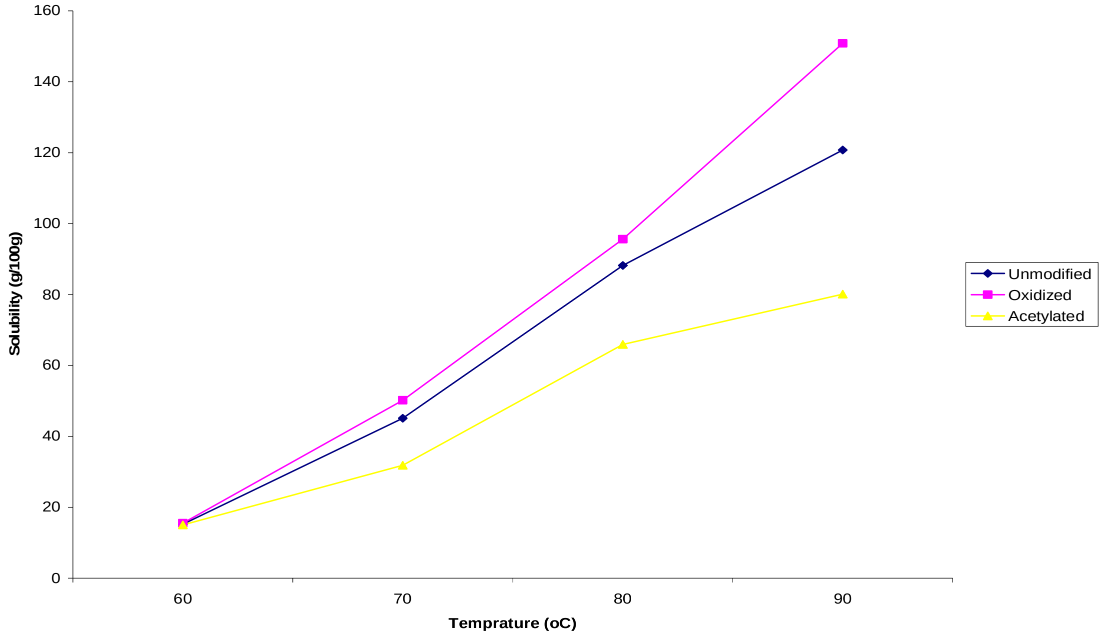

Figure 1: Effect of temperature on solubility of *Mucuna sloanei* starches

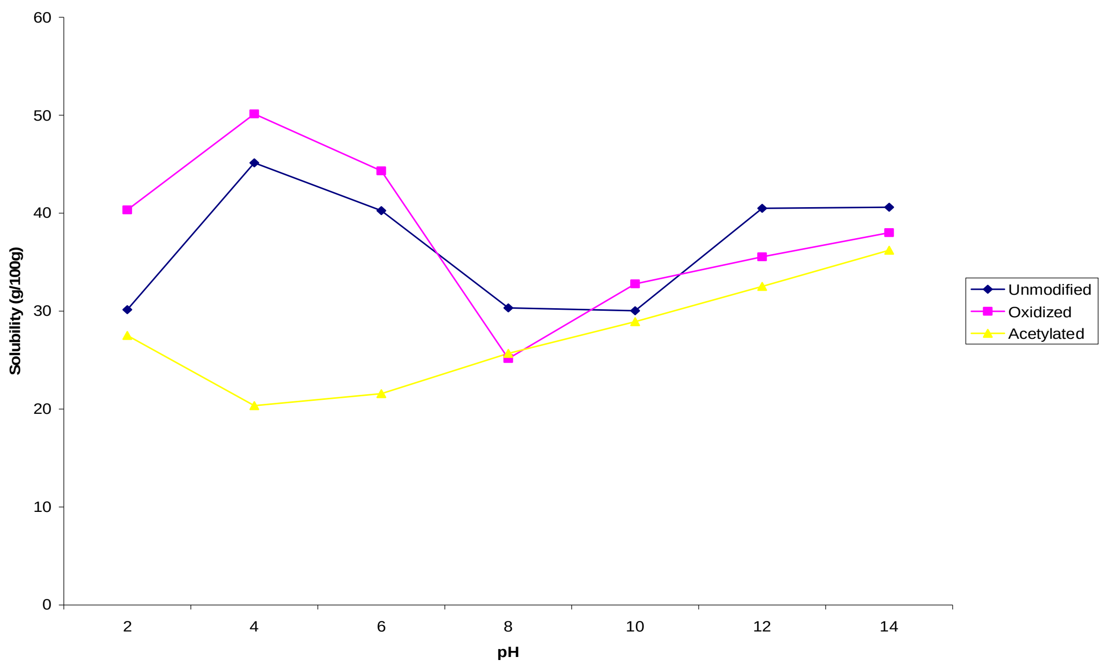

Figure 2:Effect of pH on solubility of *Mucuna sloanei* starches

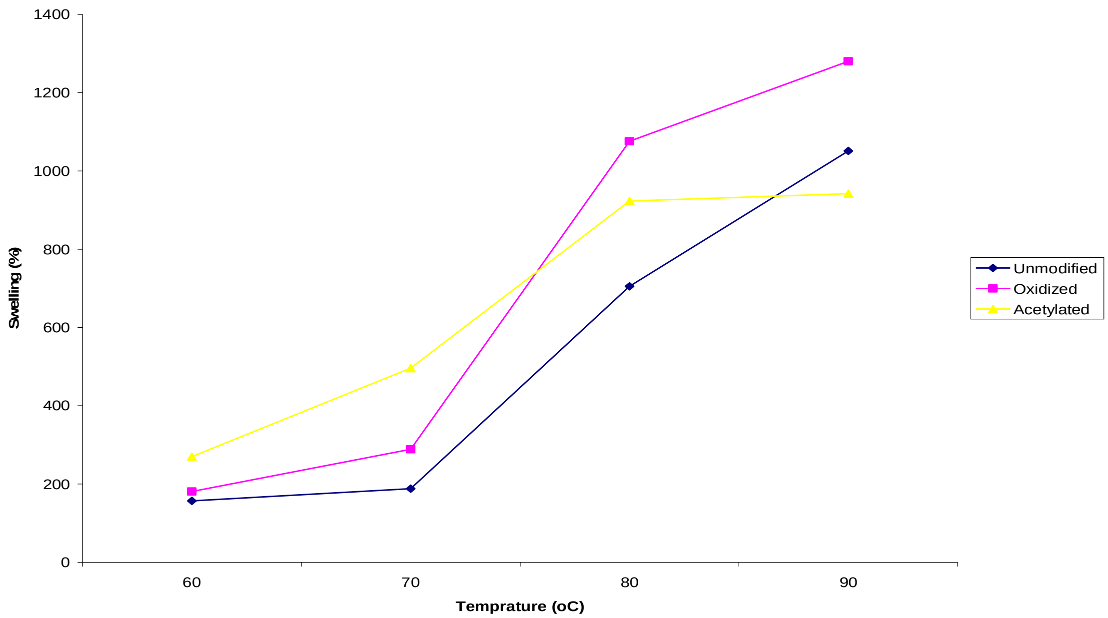

Figure 3: Effect of temperature on swelling of *Mucuna sloanei* starches

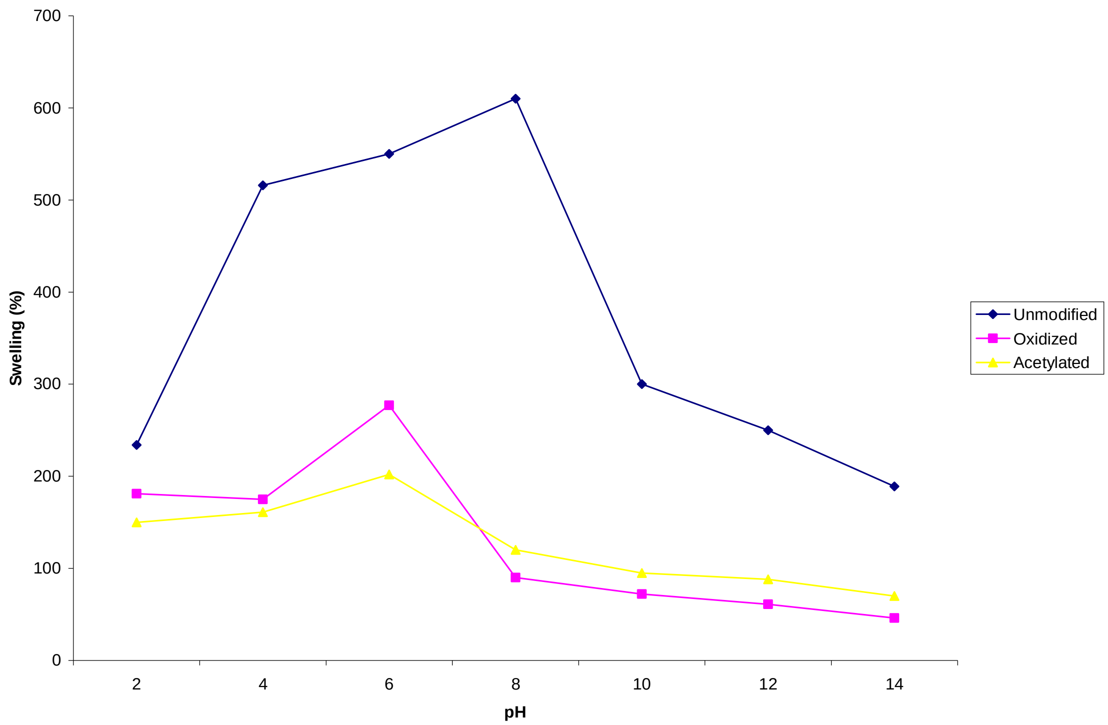

Figure 4: Effect of pH on swelling of *Mucuna sloanei* starches

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