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Effects of mucilage on the material and physico-chemical properties of native and modified starches obtained from *Ipomoea batatas*

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ABSTRACT

The aim of the present investigation was to evaluate the effect of mucilage on the material and physico-chemical properties of native and modified starches obtained from *Ipomoea batatas*. *Ipomoea batatas* starch were pregelatinized and acid modified, subsequently, dispersions of mucilage with native, pregelatinized and acid modified starches in a ratio of 1:20, 1:10, 2:10, 3:10 and 4:10 respectively were produced. The order of magnitude pregelatinized starch > acid modified starch > native starch were seen for parameters such as moisture sorption, hydration capacity and swelling capacity, while native starch > pregelatinized starch > acid modified starch for porosity and angle of repose. These orders were also observed respectively with the dispersion of the various starches in mucilage. Generally an increase in particle size, flow properties, moisture sorption capacity, true densities and a decrease in hydration capacity, swelling capacity and porosity were observed as the mucilage concentration increased.

Keywords: *Ipomoea batatas* starch, pregelatinized, acid modified, dispersion, mucilage

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INTRODUCTION

Ipomoea batatas (sweet potato) is only distantly related to *Solanum tuberosum*[1.] Among the world's root crop, it is second only to white potato (*Solanum tuberosum*) in importance [2] While in Africa, it is the third most important root crop after cassava (*Manihot esculenta*) and yam (*Dioscorea spp*) [3]

Sweet potato *(Ipomoea batatas*) is a crop plant with large, starch, and sweet tasting roots which belongs to the family Covolvulaceae. It contains a viscous polysaccharide polymer called mucilage. This substance is mainly composed of water-soluble glycoprotein's containing a number of different sugars. The major components of carbohydrate in purified mucilage of sweet potato are galactose and arabinose. Moreover, the remaining carbohydrate compositions are glucose, rhamnose, and xylose [4].

Commercial starch is generally cohesive and has poor flow characteristics. In comparison to starch, partially pregelatinized starch may be produced with enhanced flow and compression characteristics such that the pregelatinized material may be used as a tablet binder in dry-compression or direct compression processes. Also, Acid treatment can cause a breakdown of the polymeric structure in starches to obtain a less elastic but amore plastic material which is amenable to direct compression [5].

Starch and Mucilage are most commonly used as adjuvant in pharmaceutical preparations, with wide range of applications such as thickening, binding, disintegrating, suspending, emulsifying, stabilizing and gelling agent. Generally, gum and mucilage when used as tablet binder forms a very strong compact [6].Therefore, dispersions of modified starch and mucilage should combine good flowability (due to particle aggregation impacted by the mucilage), stronger compact (impacted by the mucilage and modified starches) and rapid disintegration due to the modified starch.

Increasing attention has been paid to incorporating hydrocolloids into starch-based products due to their unique functional properties [7-10], such as increasing the viscosity of starch systems [11], or improving syneresis and freeze-thaw stability [12]. The excipient industry to date has been an extension of the food industry[13]. However, the presence of mucilage in tuber crops itself, has received little attention, particularly the effects of mucilage on the micromeric properties related to tablet production. The objective of this study is to investigate the effect of increased mucilage concentrations on the material and physico-chemical properties of native, pregelatinized and acid modified starch obtained from *ipomoea batatas* in relation to tablet production.

MATERIALS AND METHOD

Materials

Ipomoea batatas (white skin, cream flesh variety) was obtained from central market in Sokoto State, Nigeria. All other chemicals and reagents used were of analytical grade.

Methods

Flour extraction

Flour extraction was conducted as established by Alves [14]. The tubers were peeled, washed, cut into 1-2 cm cubes, and sliced into thick chips (-5mm). This chip was then soaked in sodium metabisulphite solution (0.075 %) for -5 min and oven dried at 30^0 C for 40 hours until it reaches 13 % moisture. Subsequently, the dried chips were milled into flour and sifted through a 500 µm sieve, and stored under dry conditions at room temperature.

Mucilage separation

The mucilage concentrate was prepared following the method as described by Jiang and Ramsden [15] with the little modification as follows, flour sample (100g) was dispersed in 300 ml of sodium metabisulphite (0.075 %) solution and stored at 4^0 C overnight. This dispersion was centrifuged at 14,000 x g for 20 min and the supernatant (mucilage) then collected. This was followed by pellet dissolution in metabisulphite solution and centrifuged under conditions as described above. The resulting supernatant was filtered using a filter paper (110 mm diameter) and purified as followed; 150ml of the supernatant was treated with 0.5% saturated solution of calcium chloride and left overnight. Subsequently, the supernatant was carefully collected and further treated by heating at 95^o C for 30min and allowed to cool to room temperature. The resulting supernatant was precipitated using three times its volume of ethanol (96 %) and then dried in an oven 40^0 C.

Starch isolation

The pellets obtained from the centrifugation step during the mucilage separation was re-suspended in a large amount of sodium metabisulphite (0.075 %) solution and then this homogenate was passed through a 150 µm sieve. The residue was washed with sodium metabisulphite (0.075 %). The resulting slurry was left to stand overnight at 4^0 C and then centrifuged (14,000 x g; 20 min). After this, the supernatant was discarded and the colored layer manually scraped off of the starch. This centrifugation step was repeated until the supernatant layer becomes almost colorless. After the last centrifugation, the supernatant was decanted and sodium hydroxide solution (0.1 M) added to the remaining sediment (starch). This would be followed by addition of deionized water to wash the pellets until its pH becomes neural. The recovered starch was dried using an air oven at

40^{o} C for 30 hrs, ground, and sieved using a 500 µm sieve. The yield of starch based on the weight of its respective flour (100 g) was determined. The resulting starch was stored in an air tight container under dry conditions [14].

Modified starches:-

Acid modified starch

In the production of acid modified starch, four hundred and fifty grams of an aqueous suspension of starch (36 % w/w wt starch) was poured into a stainless steel vessel. To this suspension, 28ml, 6N HCI was added drop wise with stirring and subsequently, the reaction was conducted for 6 hours at 54^{0} C. After cooling, the acid modified starch was separated from the reaction medium by filtration. On the filtrate, the separated starch was washed 1:1 with water, then the starch suspended again in 250 ml water and adjusted to pH 7 with sodium hydroxide. The starch product was separated by means of filtration with water and dried in an oven at 40^{0} C to a moisture content of <10 %, Then ground into a powder and passed through a 500 µm sieve.

Pregelatinized starch

In the production of partially pregelatinized starch, native Starch 39.6 g was added to 70ml of distilled water and the suspension stirred for 10 min at room temperature. The suspension was heated on a water bath thermostatically maintained at a temperature of 55^{0} C (i.e. below the gelatinization temperature) for 15 minutes, the resultant paste was dried in a hot air oven at temperature of 40^{0} C to a moisture content of <10 %, then ground into a powder and passed through a 500 µm sieve.

Starch and mucilage dispersions

Production of mucilage/native starch, mucilage/pregelatinized starch and mucilage/ acid hydrolyzed starch dispersions in a ratio 5:100, 10:100, 20:100, 30:100 and 40:100 respectively was carried out as follows: *Ipomoea batatas* mucilage was slowly added to distilled water (150 ml) with stirring until dissolution is affected. Starch (native, pregelatinized or acid modified) was then added to the mucilage solutions, and the dispersion stirred for one hour at room temperature. The whole dispersion was then transferred into a glass dish and dried at 45^{0} C in an oven to a moisture content of <10 %, ground into a powder and passed through a 500 µm sieve.

Physicochemical properties

The organoleptic characteristics, total ash determination, pH and moisture content were carried out in accordance with British Pharmacopoeia specification

Moisture sorption capacity

2 g of the starch material was accurately weighed and evenly distributed over the surface of a 70mm tarred Petri dish. The samples were placed in large desiccators containing distilled water (RH=100%) and saturated sodium chloride solution (RH=75 %) in their reservoirs at room temperature and the weight gained by the exposed sample at the end of a five day period was recorded and the amount of water sobbed calculated from the weight differences .

True density

The true density (D_1) of the starch was determined by the liquid displacement method using xylene as the immersion fluid as described by Ohwoauvorhua[16] & computed according to the following equation.

$$D_1 = W/ [(a+w) – b] \times SG$$

Were w is the weight of the powder, SG is specific gravity of liquid, a, is Weight of bottle + liquid and b is weight of bottle + solvent + powder.

Granular morphology and particle size

Scanning electron micrographs (SEM) was obtained using a scanning electron microscope (EVO/MA 10, Carl Zeiss NTS.). Starch samples were applied onto aluminum stubs using double-sided adhesive tape. The samples were coated with gold-palladium. An accelerated potential of 15kv was used during the electron micrograph. Particle size was determined using a laser diffraction analyzer (MSS Mastersizer-5, Malvern Instruments, UK) at room temperature.

Bulk and tapped densities

A 10g quantity of the powder sample was Placed in 50ml clean, dry measuring cylinder and the volume V_o occupied By the sample without tapping determined. After 500 manual taps, occupied volume V500 was determined. The bulk and tapped densities was calculated as the ratio of the weight of weight of volume (V_o and V_{500} respectively). The Carr's index and Hausner's ratio were determined from the values of the bulk and tapped densities results obtained above.

Angle of repose

The static angle of repose, a was measured according to the fixed funnel and free standing cone method and the tangent of the angle of repose calculated using the equation

$$\text{Tan } a = 2h/D.$$

Were h is the height of the heap of powder and D is the diameter of the base of the heap of powder.

Powder porosity

This was determined from the values of true and bulk densities when fitted into the equation according to the method of Ohwoauvorhua [16]:

$$e = 1\text{-}B_b/D_t \times 10$$

Were BЬ, is the bulk density, D, is the true density and e is the porosity

Hydration capacity

The method of Kornblum and stoopak [17] was used. A 1g sample was placed in each of four 15ml plastic centrifuge tubes and 10ml distilled water added from a 10ml measuring cylinder and then stopped. The contents was mixed on a vortex mixer for 2 min. The mixture then allowed to stand for 10min and immediately centrifuged. The supernatant was carefully decanted and the sediment weighed. The hydration capacity was taken as the ratio of the weight of the sediment to the dry sample weight.

Swelling capacity

This was determined at the same time as the hydration determination using the method of Okhamafe [18] and computed according to the following equation;

$$S = (V_2 - V_1)/V_1 \times 100\%$$

Where S is the % swelling capacity, V_2 is the volume of the hydration or swollen material and V_1 is the tapped volume of the material prior to hydration.

Statistical analysis

The mean values and standard deviations of each analysis were reported. Analysis of variance (ANOVA) was performed as part of the data analyses. When F-values were significant ($p < 0.05$).

Keys to abbreviations

SPS (sweet potato starch), PPS (pregelatinized sweet potato starch), APS (acid modified sweet potato starch). 5-MSPS, 10-MSPS, 20-MSPS, 30-MSPS and 40-MSPS (represents 5,10,20,30 and 40 grams of mucilage incorporated into 100 grams of sweet potato starch respectively). 5-MPPS, 10-MPPS, 20-MPPS, 30-MPPS and 40-MPPS (represents 5,10,20,30 and 40 grams of mucilage incorporated into 100 grams of pregelatinized sweet potato starch respectively). 5-MAPS, 10-MAPS, 20-MAPS, 30-MAPS and 40-MAPS (represents 5,10,20,30 and 40 grams of mucilage incorporated into 100 grams of acid modified sweet potato starch respectively)

RESULTS AND DISCUSSION

All starch samples except SPS, PPS and APS possessed slight characteristics sweet taste with increasing sweetness as the ratio of the mucilage increased. SPS, 5-MSPS, 10-MSPS, PPS, 5-MPPS, 10-MPPS, APS, 5-MAPS and 10-MAPS where off white while 20-MSPS, 30-MSPS, 40-MSPS, 20-MPPS, 30-MPPS, 40-MPPS, 20-MAPS, 30-MAPS and 40-MAPS are light brown in coloration. All starch samples appeared round, spherical or irregular in shape as seen in Figure. 2.

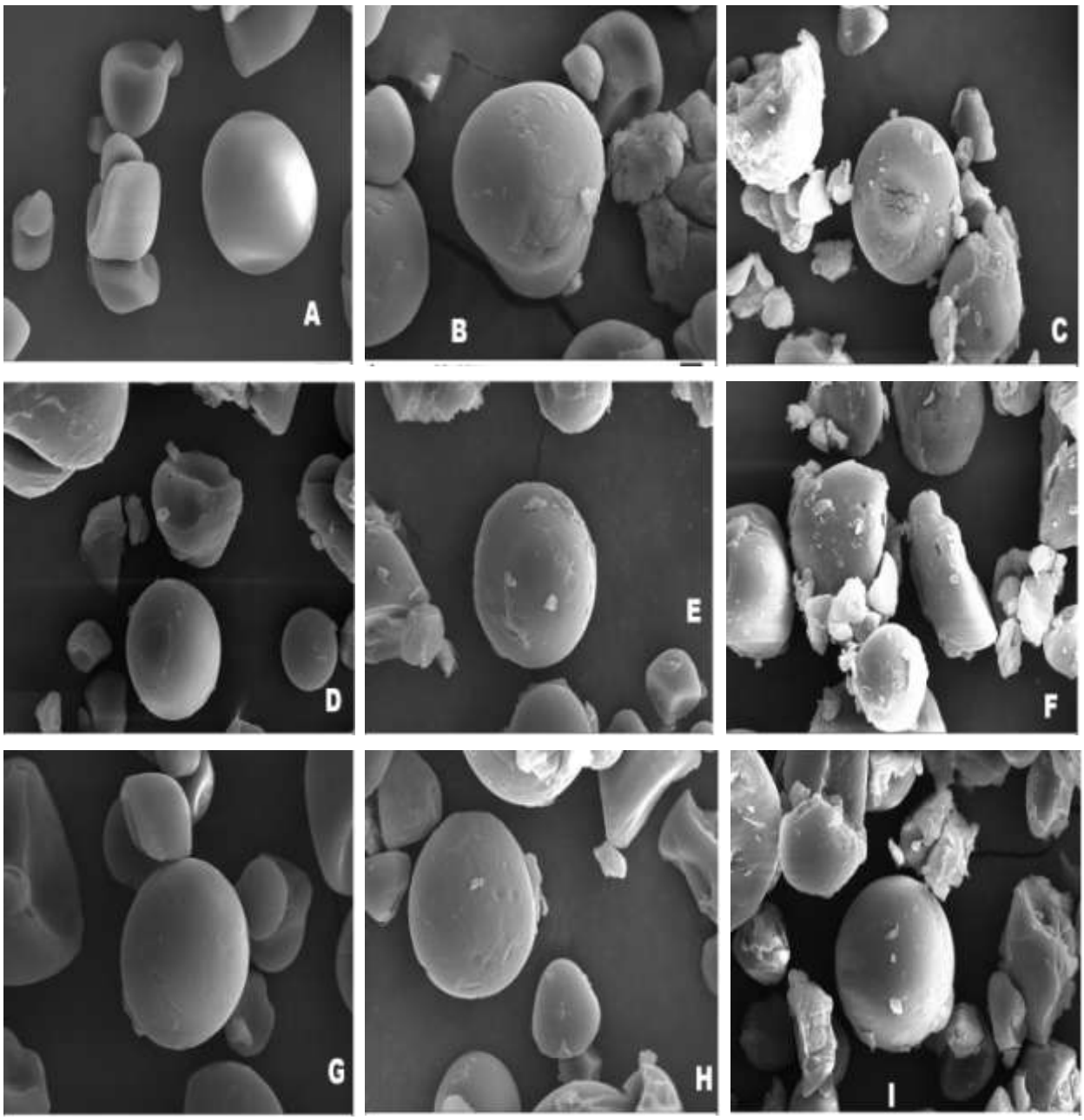

Figure 2: Scanning electron micrographs of SPS (A), 10-MSPS (B), 30-MSPS (C), PPS (D), 10-MPPS (E), 30-MPPS (F), APS (G), 10-MAPS (H) and 30-MAPS (I). [Magnification = 2.00 KX]

There was an increment in moisture sorption capacity and true density with a decrease in moisture content and pH with increased mucilage concentration as seen in Table 1.

Moisture content and ash value were all below 15 % and 0.6 % as stipulated for starches in the British Pharmacopoeia [19].

Table 1: Micromeric properties of starch, modified starch and dispersions of modified starch and mucilage obtained from *Ipomoea batatas*

Parameters	Moisture content (%)	Moisture sorption capacity (%)		True density (g/cm^2)	Ash value (%)	pH
		RH=75%	RH= 100%			
SPS	12.0 (0.46)	2.5 (0.46)	24.5 (0.28)	1.32 (0.12)	0.51 (0.02)	6.85
5-MSPS	6.0 (0.91)	4.5 (0.34)	34.5 (0.24)	1.41 (0.20)	0.50 (0.11)	6.69
10-MSPS	6.5 (1.20)	5.0 (0.26)	33.5 (0.18)	1.48 (0.08)	0.58 (0.08)	6.29
20-MSPS	5.0 (1.05)	6.5 (0.34)	43.5 (0.20)	1.54 (0.12)	0.56 (0.12)	6.26
30-MSPS	5.0 (0.86)	7.0 (0.22)	54.5 (0.32)	1.56 (0.06)	0.56 (0.02)	6.30
40-MSPS	5.0 (0.94)	9.0 (0.26)	59.5 (0.16)	1.56 (0.08)	0.59 (0.04)	6.21
PPS	5.0 (0.22)	7.0 (0.14)	30.0 (0.32)	1.48 (0.11)	0.58 (0.10)	6.82
5-MPPS	5.0 (0.40)	5.5 (0.20)	33.0 (0.22)	1.54 (0.12)	0.50 (0.08)	6.21
10-MPPS	5.0 (0.20)	5.0 (0.22)	34.5 (0.42)	1.54 (0.08)	0.51 (0.12)	6.14
20-MPPS	5.0 (0.62)	7.0 (0.18)	46.5 (0.33)	1.54 (0.14)	0.47 (0.06)	5.93
30-MPPS	5.0 (0.12)	8.0 (0.12)	56.0 (0.28)	1.59 (0.02)	0.54 (0.11)	5.79
40-MPPS	5.0 (0.32)	10.0 (0.1)	61.5 (0.22)	1.59 (0.10)	0.45 (0.14)	5.37
APS	7.5 (0.22)	6.5 (0.10)	25.5 (0.34)	1.56 (0.10)	0.53 (0.08)	6.85
5-MAPS	5.5 (0.18)	6.0 (0.46)	31.0 (0.22)	1.65 (0.14)	0.50 (0.12)	6.66
10-MAPS	5.5 (0.20)	6.0 (0.64)	35.5 (0.18)	1.65 (0.08)	0.50 (0.10)	6.29
20-MAPS	6.0 (0.24)	7.5 (0.48)	43.5 (0.20)	1.72 (0.12)	0.48 (0.14)	6.00
30-MAPS	6.0 (0.46)	9.5 (0.22)	54.0 (0.34)	1.79 (0.20)	0.49 (0.08)	5.81
40-MAPS	5.5 (0.24)	10.5 (0.4)	60.0 (0.08)	1.79 (0.02)	0.52 (0.11)	5.70

*value is mean and standard deviation is in parenthesis, number of replicate = 3

Particle size analysis showed that the surface area mean diameter , D [3, 2], mass median diameter D [v, 0.5] and particles less than 10 % D [v, 0.1] for native, pregelatinized and acid modified starches were in the order, native starch > acid modified starch > pregelatinized starch while the volume mean diameter D [4, 3], and particles less than 90 % D [v, 0.9] were in the order pregelatinized starch > acid modified starch > native starch. Generally, there was a slight increment in specific surface area, D [4, 3], D [v, 0.5] and D [v, 0.9] with a decrease in D [v, 0.1] as the mucilage ratio increased with all samples as seen in Table 2,3,4 and Figure 1.. This might be due to adsorption of mucilage to the surface of starch grains and particle aggregation.

The angle of repose for native starch, pregelatinized starch and acid modified starch were in the order native starch > pregelatinized starch > acid modified starch. This trend was also reflected with their dispersions in mucilage. Increase in mucilage concentration generally lead to an inprovement in flow characteristics as seen with a decrease in angle of repose (Figure. 3) and a decrease in Carr's index and Hausner's ratio (Table 5.). This is in correlation with the increase in D [v. 0.9] and a decrease in D [v. 0.1] as seen in Table 2, 3 and 4.

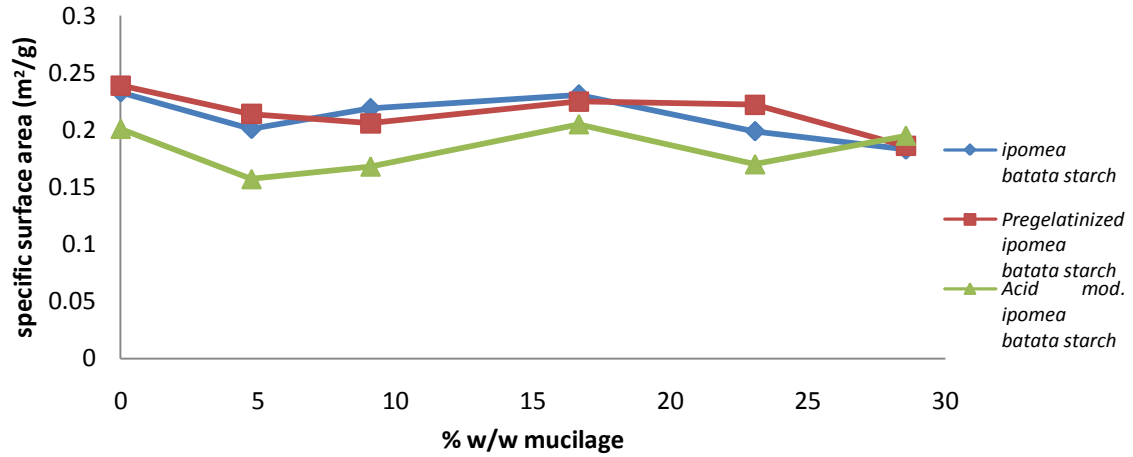

Figure 1: Effect of mucilage concentrations on the specific surface area of starch and modified starches obtained from *Ipomoea batatas*

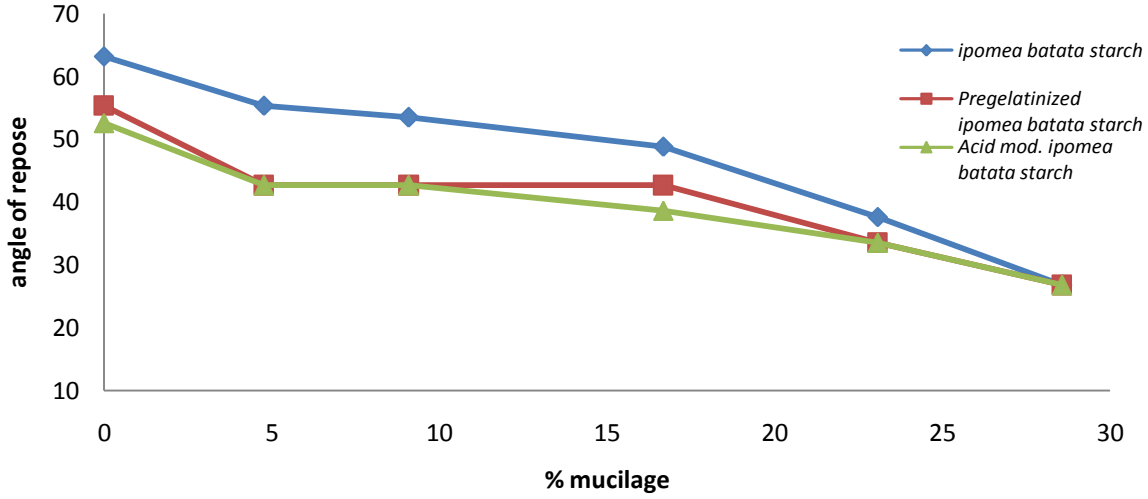

Figure 3: Effect of mucilage concentrations on the angle of repose of starch and modified starches obtained from *Ipomoea batatas*

Table 2: Particle properties of starch and dispersions of starch and mucilage obtained from *Ipomoea batatas*

Parameters	SPS	5-MSPS	10-MSPS	20-MSPS	30-MSPS	40-MSPS
D[4,3] (µm)	53.45^{a} (1.23)	105.37^{b} (4.22)	82.65^{c} (6.13)	103.31^{b} (2.03)	138.84^{d} (7.70)	160.80^{d} (13.92)
D[3,2] (µm)	19.45^{a} (0.13)	21.21^{b} (0.28)	18.52^{a} (0.29)	16.86^{c} (0.18)	19.32^{a} (0.54)	21.02^{b} (0.72)
D[v, 0.1] (µm)	11.55^{a} (0.05)	11.78^{a} (0.06)	11.11^{a} (0.07)	9.81^{b} (0.04)	10.34^{b} (0.12)	10.88^{b} (0.29)
D[v, 0.5] (µm)	28.31^{a} (0.23)	33.00b (0.84)	26.08^{c} (0.40)	25.96^{c} (0.28)	36.90^{d} (2.58)	55.74^{e} (12.20)
D[v, 0.9] (µm)	137.69^{a} (3.52)	314.39^{b} (14.99)	262.22^{c} (21.81)	333.71^{b} (7.13)	407.88^{d} (19.54)	448.07^{d} (32.46)

D [4, 3] (volume mean diameter), D [3, 2] (surface area mean diameter), D [v, 0.1] (particle size less than 10% sample size), D [v, 0.5] (mass median diameter),), D [v, 0.9] (particle size less than 90% sample size. *value is mean and standard deviation is in parenthesis, number of replicate = 3, a–e Means with different letters within the same row differed significantly ($p < 0.05$)

Table 3: Particle properties of pregelatinized starch and dispersions of pregelatinized starch and mucilage obtained from *Ipomoea batatas*

Parameters	PPS	5-MPPS	10-MPPS	20-MPPS	30-MPPS	40-MPPS
D[4,3] (µm)	80.19^{a} (0.25)	103.33^{b} (4.60)	103.05^{b} (0.96)	111.67 (8.35)	110.09 (12.20)	156.80 (3.43)
D[3,2] (µm)	17.01^{a} (0.45)	18.23^{a} (0.48)	18.87^{a} (0.19)	17.36^{a} (0.45)	17.05^{a} (0.46)	20.29 (0.21)
D[v, 0.1] (µm)	10.26^{a} (0.08)	10.41^{a} (0.08)	10.96^{a} (0.03)	9.86^{a} (0.13)	9.27^{a} (0.10)	10.12^{a} (0.10)
D[v, 0.5] (µm)	26.24^{a} (0.61)	28.36^{a} (0.55)	27.83^{a} (0.43)	28.10^{a} (1.16)	32.40^{b} (1.81)	77.68^{c} (4.69)
D[v, 0.9] (µm)	253.30^{a} (26.61)	317.75^{b} (11.31)	321.92^{b} (3.95)	344.82^{b} (25.10)	326.54^{b} (35.76)	417.63^{c} (7.95)

*value is mean and standard deviation is in parenthesis, number of replicate = 3, a–d Means with different letters within the same row differed significantly ($p < 0.05$)

Table 4: Particle properties of acid modified starch and dispersions of acid modified starch and mucilage obtained from *Ipomoea batatas*

Parameters	APS	5-MAPS	10-MAPS	20-MAPS	30-MAPS	40-MAPS
D[4,3] (µm)	77.08^{a} (7.62)	152.20^{b} (6.01)	153.71^{b} (9.91)	108.09 (0.69)	142.65^{b} (9.20)	123.35 (6.65)
D[3,2] (µm)	19.15^{a} (0.23)	23.15^{b} (0.44)	21.68^{b} (0.81)	17.02^{a} (0.10)	19.80^{a} (0.57)	17.17^{a} (0.18)
D[v, 0.1] (µm)	11.37^{a} (0.05)	11.48^{a} (0.13)	10.88^{a} (0.21)	9.53^{b} (0.03)	10.04^{a} (0.16)	9.09^{b} (0.03)
D[v, 0.5] (µm)	27.30^{a} (0.42)	55.72^{b} (3.40)	50.03^{b} (9.30)	30.78^{a} (0.66)	55.78^{b} (6.63)	39.35^{c} (1.46)
D[v, 0.9] (µm)	232.87^{a} (25.37)	421.72^{b} (18.07)	435.63^{b} (22.73)	323.61^{c} (3.25)	391.86^{c} (24.24)	354.98^{c} (19.91)

*value is mean and standard deviation is in parenthesis, number of replicate = 3, a–d Means with different letters within the same row differed significantly ($p < 0.05$)

Table 5: Micromeritic properties of starch, modified starches and dispersions of modified starch and mucilage obtained from *Ipomoea batatas*

Parameters	Bulk density (g/cm^3)	Tapped density (g/cm^3)	Carr's index (%)	Hausner's index
SPS	0.51 (0.04)	0.73 (0.01)	30.40	1.44
5-MSPS	0.52 (0.03)	0.75 (0.01)	30.67	1.44
10-MSPS	0.54 (0.04)	0.77 (0.02)	29.87	1.43

20-MSPS	0.57 (0.02)	0.80 (0.01)	28.75	1.40
30-MSPS	0.61 (0.03)	0.83 (0.02)	26.51	1.36
40-MSPS	0.61 (0.02)	0.83 (0.01)	26.51	1.36
PPS	0.56 (0.02)	0.77 (0.01)	27.27	1.38
5-MPPS	0.63 (0.01)	0.83 (0.01)	24.10	1.32
10-MPPS	0.63 (0.01)	0.83 (0.01)	24.10	1.32
20-MPPS	0.63 (0.01)	0.83 (0.01)	24.10	1.32
30-MPPS	0.67 (0.01)	0.83 (0.01)	19.93	1.25
40-MPPS	0.67 (0.01)	0.83 (0.01)	19.93	1.25
APS	0.54 (0.01)	0.72 (0.01)	25.00	1.33
5-MAPS	0.59 (0.01)	0.77 (0.01)	23.38	1.31
10-MAPS	0.59 (0.01)	0.77 (0.01)	23.38	1.31
20-MAPS	0.61 (0.01)	0.78 (0.01)	21.80	1.28
30-MAPS	0.63 (0.01)	0.80 (0.01)	21.25	1.27
40-MAPS	0.63 (0.01)	0.80 (0.01)	21.25	1.27

*value is mean and standard deviation is in parenthesis, number of replicate = 3

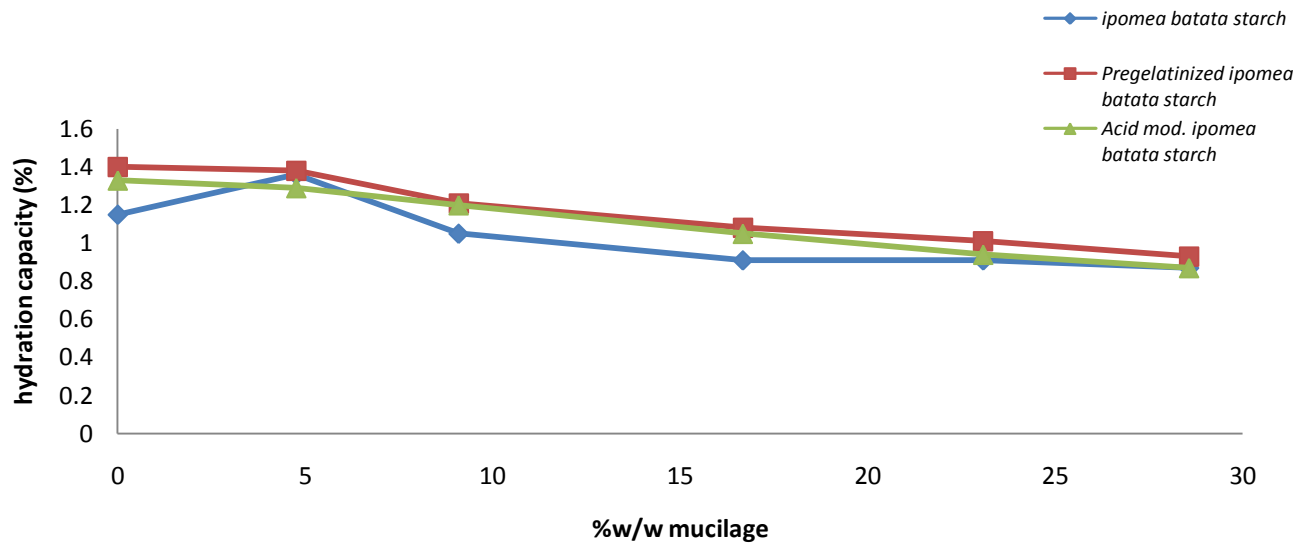

Figure 4: Effect of mucilage concentrations on hydration capacity of starch and modified starches obtained from *Ipomoea batatas*

Generally, there was a decrease in hydration capacity, swelling capacity and porosity as seen in Figure. 4, 5 and 6 respectively with increase mucilage concentration. Generally, the moisture sorption, hydration and swelling capacity were in the order pregelatinized starch > acid modified starch > native starch and for porosity, native starch > pregelatinized starch > acid modified starch. These trends were also seen with their dispersions in mucilage. The increase in moisture sorption capacity is as a result of high affinity for water by hydrocolloids. Increase in the true densities of the starches is as a result of increase in molecular weight brought about by penetration of mucilage into the interior of the starch granules and also adsorption to its surfaces which leads to decrease in intra and interstitial spaces and subsequently reduction in porosity. The hydration and swelling

power of starch indicates the degree of water absorption of starch during the starch swelling procedure[20]. The decrease in hydration and swelling capacity of starch and its modified products by mucilage could be as a result of enlarged submicropores of the starch granules [7], also as a result of hydrocarbon chains of internal lipids, which suppresses hydration of the amorphous regions of starch granules [8], antiplastisizing effect of hydrocolloid compared with water, the influence of sugar-starch interaction and effect of sugars on water structures [10].

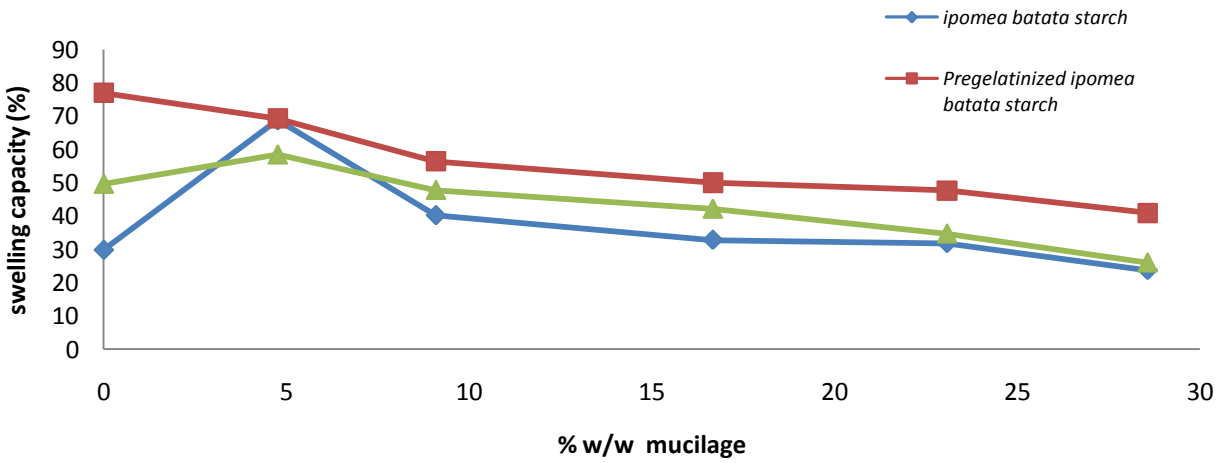

Figure 5: Effect of mucilage concentrations on swelling capacity of starch and modified starches obtained from *Ipomoea batatas*

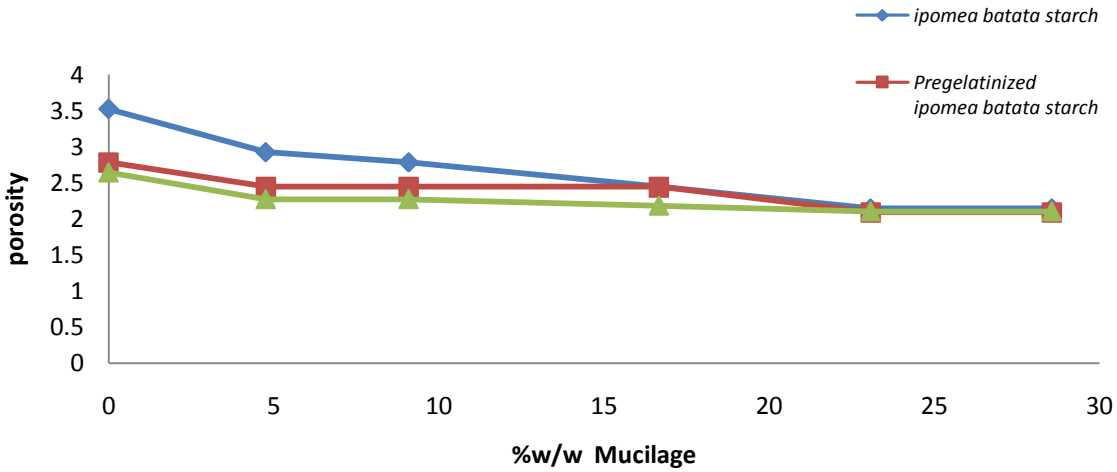

Figure 6: Effect of mucilage concentrations on porosity of starch and modified starches obtained from *Ipomoea batatas*

CONCLUSION

Incorporation of mucilage increased the sweetness of native and modified starches obtained from *ipomoea batatas*; there was also a decrease in hydration, swelling and porosity with an increase in

flow properties of the excipient. These properties would be evidently important if the excipient is to be considered for chewable tablets.

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