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PHYSICOCHEMICAL EVALUATION OF α-CELLULOSE OBTAINED FROM DESTARCHED WHITE AND YELLOW MAIZE CHAFF I: DIRECT COMPRESSION PROPERTIES

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ABSTRACT

The physicochemical and direct compression properties of cellulose powders extracted from de-starched white and yellow maize chaff has been investigated. Extraction of the α-cellulose powders of the maize chaffs was done by acidic delignification using nitric acid. The cellulose powders extracted were subjected to physicochemical and Fourier transform infra-red (FTIR) analyses. Thereafter, tablet compresses of the powders were formulated using three compression pressures. The cellulose compacts were evaluated for their tablets properties. The extracted cellulose powders were white in colour, tasteless, insoluble in water and gritty in texture. They reacted negatively to the presence of starch, sugar and lignin but positively to cellulose. They exhibited the following properties; fair to poor flowability, angle of repose (≥ 40°), Hausner's ratio (≥ 1.40) Carr's index (≥ 28.54%), hydration capacity (≥ 4.25%), moisture content (≤ 2.20%) and swelling capacity (≤ 79%). FTIR analysis showed very similar and comparable characteristic spectra for the cellulose powders. Cellulose powder tablets compressed at different compression pressures showed good tablet strength (> 4.45 kp, > 4.12 N/m^2) and friability values (≤ 0.8%). The porosity, swelling indices and moisture sorption capacities of the tablets were > 0.60, > 27.20% and > 36.20%, respectively. The study has shown that the extracted α-cellulose from white and yellow maize chaffs exhibits comparable physicochemical properties and their tablet formulations at different compression pressures also showed comparable tableting properties, hence the obtained α-cellulose powders can be used as a direct compression excipient in solid dosage forms because of their high compression and binding ability.

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1. INTRODUCTION

Pharmaceutical excipients are natural or synthetic auxiliary substances which are therapeutically inactive, and are added to a solid dosage form to impact satisfactory compression characteristics to the formulation and to give additional desirable physicochemical properties such as sufficient size, appearance, hardness, disintegration ability and compendial conformity to the finished product. Natural materials have gained a lot of significance in the field of drug delivery because they are cost effective, non-toxic, eco-friendly, stable, easily available, capable of multiple chemical modifications, compatible due to their natural origin and have less regulatory issues (Skinner et al., 1998; Uwaezuoke et al., 2014). The present trend of sourcing pharmaceutical excipients from natural sources such as plants, animals and agricultural waste is as a result of the steady shift from use of synthetic materials to renewable resources, waste management and green technology (Uwaezuoke et al., 2014). Wastes are residues left and intended for disposal after the essential part of a plant material has been utilized for food or processed into other important and useful materials. The production of starch from maize results in a highly fibrous chaff which is usually discarded as a waste product or used to supplement poultry feeds (Sonaiya, 1993). An efficient utilization and transformation of agricultural waste into pharmaceutical excipients could be the solution to the pollution problems of agricultural waste in Africa. In addition to minimizing the environmental impact of the wastes, this could also serve as a source of revenue generation (Uwaezuoke et al., 2014).

Cellulose is a high molecular weight linear polymer of about 1000-3000 β-D-glucose units per molecule. The glucose monomers are joined by 1,4-glycosidic linkages. The number of glucose units or the degree of polymerisation depends on the source and method of isolation (Heinze and Liebert, 2012). Alpha cellulose is obtained as a pulp from fibrous plant materials when treated with mineral acids (Ohwoavworhua and Adelakun, 2005). Although it is used in the pharmaceutical industry mainly as a filler or diluent in tableting, its many derivatives such as microcrystalline cellulose (MCC), hydroxylpropyl methylcellulose (HPMC), carboxymethyl cellulose (CMC), etc, have many other applications (Marques-Marinho and Vianna-Soares, 2013). Pharmaceutical grade cellulose is sourced mainly from wood, in which cellulose chains are packed in layers held together by a cross-linking polymer (lignin) and strong hydrogen bonds. Cotton has also been investigated as a possible source of cellulose (Suzuki and Nakagami, 1999; Shlieout et al., 2002).

The objective of this study was to evaluate the physicochemical properties of α-cellulose extracted from the chaffs of destarched white and yellow maize and to investigate its possible application as a direct compression excipient in tablet formulations.

2. MATERIALS AND METHODS

2.1. Materials

Maize (*Zea mays* L) chaffs of white and yellow varieties were collected as starch processing wastes from a local starch processor in Benin City, Nigeria. Nitric acid (May and Baker Ltd, UK), sodium hydroxide (Merck, Germany), sodium hypochlorite (Reckitt and Colman

Nigeria Ltd., Lagos), hydrochloric acid, sodium nitrite, sodium sulphite (BDH Chemicals Ltd. Poole England), phloroglucinol (Hopkin and Williams, UK) were used as reagents in this study. All sieves were British Standard Sieves (Endecotts) and water was double distilled.

2.2. Methods

2.2.1 Extraction of α-cellulose

Using the method of Ohwoavworhua et al., (2007), the collected maize chaff was sun-dried for 48 h and then micronized in a Fitz mill (Manesty Machines UK) into fine powders. Four hundred grams of the powder was treated for 2 h in a stainless steel vessel maintained at 90 °C with 4 litres of 3.5 % nitric acid containing 40 mg of sodium nitrite to remove lignin in the form of nitrolignin. The sample was washed thoroughly, filtered with a sieve (No. 18) and digested with a 4 litres solution containing 2.0 % w/v each of sodium hydroxide and sodium sulphite at a temperature of 50 °C for 1 h. The sample was washed thoroughly with distilled water, filtered and bleached with 1 litre of diluted aqueous solution of 3.85 %w/v sodium hypochlorite 40 °C for 1.5 h. The bleached sample (holo-cellulose) was thoroughly washed with distilled water, filtered and subsequently treated with 2 litres of 17.5 % w/v sodium hydroxide solution at 80 °C for 30 min. The resulting material was again washed thoroughly with distilled water, filtered and then bleached with 2 litres of diluted aqueous solution of 3.85 %w/v sodium hypochlorite at 40 °C for 1.5 h. The product (alpha-cellulose) was washed with more distilled water and air dried for 24 h and further oven dried (Kottermann, Germany) for 1 h at 60 °C. The alpha cellulose was milled in a blender (Moulinex, France) and screened through a 212 µm sieve, weighed and the percentage yield calculated before being stored in an air tight container.

2.2.2. Physicochemical characterization of the cellulose powder

2.2.2.1. *Organoleptic properties*

The texture, colour and odour of the cellulose powder were noted.

2.2.2.2. *Solubility*

The solubility profile of a 100 mg quantity of the cellulose powder was determined in 2 ml of water at ambient temperature. The powder was dispersed in the water in a test-tube and shaken. The dispersion was filtered using a filter paper (Whatman No. 1) and the residue air dried. The dried residue and the filter paper was weighed (Mettler Toledo, Switzerland) and the difference in weight was used as a measure of solubility of the powder.

2.2.2.3. *Test for starch and reducing sugar*

A few drops of iodine solution was added to 10 mg of the cellulose powders in a test tube and the colour change noted. To a 5 ml dispersion of the cellulose powder in a test tube was added an equal volume of Benedict's solution. The mixture was boiled, allowed to cool and the colour change was noted (British Pharmacopeia, 2009).

2.2.2.4. Test for cellulose and lignin

A few drops of iodinated zinc chloride solution was added to 10 mg of the cellulose powder in a test tube and the colour change was noted. For lignin content, about 100 mg of the

cellulose powder was moistened with a few drops of concentrated hydrochloric acid on a glass slide. Two drops of phloroglucinol was added to the moistened powder and the glass slide heated over a Bunsen burner until the liquid content was completely evaporated. The slide was examined under a light microscope for any colouration (British Pharmacopeia, 2009).

2.2.2.5. *Bulk density*

Cellulose powder (20 g) was weighed and transferred gently into a 100 ml measuring cylinder. The volume occupied by the powder was recorded as the bulk volume. Triplicate determinations were carried out and the average value generated was used to calculate the bulk density employing Equation (1) (Ohwoavworhua et al., 2007).

$$\text{Bulk density} = \frac{\text{Mass of powder}}{\text{Volume of powder}} \quad (1)$$

2.2.2.6. *Tapped density*

The measuring cylinder containing the 20 g powder was tapped mechanically on a flat surface about 100 times to a constant volume which was recorded as the tapped volume. Triplicate determinations were carried out and the average value generated was used to calculate the tapped density using Equation (2) (Ohwoavworhua et al., 2007).

$$\text{Tapped density} = \frac{\text{Mass of powder}}{\text{Tapped volume of powder}} \quad (2)$$

2.2.2.7. *Carr's (Compressibility) index*

Using Equation (3), the difference between the tapped and bulk density of the cellulose powders divided by the tapped density was calculated and the ratio expressed as a percentage to give the Carr's index (Carr, 1965).

$$\text{Carr's index} = \frac{\text{Tapped density} - \text{Bulk density}}{\text{Tapped density}} \times 100 \quad (3)$$

2.2.2.8. *Hausner's ratio*

The ratio of the tapped density to the bulk density of the cellulose powders was calculated as the Hausner's ratio or quotient using Equation (4) (Ohwoavworhua et al., 2007).

$$\text{Hausner's ratio} = \frac{\text{Tapped density}}{\text{Bulk density}} \quad (4)$$

2.2.2.9. *True (particle) density*

A 25 ml specific gravity bottle (glass pycnometer) was filled with liquid paraffin, cleaned of any residual liquid paraffin and weighed and the mass was recorded as a. The bottle was emptied, rinsed with acetone and dried. About 1 g (b) of the cellulose powder was transferred into the bottle and then the bottle was filled with liquid paraffin. The bottle and its content

was weighed after cleaning off the residual paraffin from the bottle and the mass was recorded as c. The various masses recorded were used to calculate the true density of the cellulose powder using Equation (5) (Irwin et al., 2002; Eichie et al., 2005; Ohwoavworhua et al., 2007). The test was carried out in triplicate.

$$\rho = \frac{b}{[(a+b)-c]} \times S \tag{5}$$

Where ρ is the particle density of the powder and S is the specific gravity of liquid paraffin

2.2.2.10. ***Powder porosity***
The porosity of the cellulose powders was calculated using Equation (6) (Ohwoavworhua et al., 2007).

$$\text{Powder porosity} = 1 - \frac{\text{Bulk density}}{\text{True density}} \tag{6}$$

2.2.2.11. ***Flow rate***
The time taken for 40 g of the cellulose powder to pass through the orifice of an Erweka flow tester was recorded. This was carried out in triplicates and the mean values recorded.

2.2.2.12. ***Angle of repose***
The hollow cylinder method was used. A hollow cylinder of 3 cm in diameter fixed to a flat surface was filled with the cellulose powders. The cylinder was slowly pulled up allowing powders to form a cone-like heap on the flat surface. The height of the heap was measured and the angle of repose, θ, was calculated using Equation (7) (Iwuagwu and Onyekweli, 2002).

$$\theta = \tan^{-1} \frac{\mathrm{h}}{\mathrm{r}} \tag{7}$$

Where h is the height of the heap of powder and r is the radius of the circular base

2.2.2.13. ***Hydration capacity***
One gram (1 g) of the cellulose powder was introduced into each of four (4) 15 ml centrifuge tubes. The tubes were covered after 10 ml of water was added. The tube contents were shaken for about 2 min, allowed to settle for 10 min and centrifuged at 1000 rpm for 10 min using a bench centrifuge. The resulting supernatant was decanted and the sediment weighed. The hydration capacity was determined using Equation (8).

$$\text{Hydration capacity} = \frac{W_B}{W_A} \tag{8}$$

Where W_B and W_A are the weights of the sediment and the powder sample, respectively.

2.2.2.14. ***Moisture content***

One gram (1 g) of the cellulose powder was dried to a constant mass in a hot air oven for 4 h at 105 ºC. The initial mass of the powder and the mass after drying were recorded and used to calculate the moisture content.

$$\text{Moisture content} = \frac{\text{Initial mass} - \text{Final mass}}{\text{Final mass}} \times 100 \quad (9)$$

2.2.2.15. ***Swelling capacity***

Using the method of Okhamafe et al. (1991), about 2 g of the cellulose powder with a tapped volume (V*a*) in a 100 ml measuring cylinder was dispersed in 85 ml of distilled water and thereafter made up to the mark with more water. The dispersion was allowed to stand for 24 h and the volume of the sediment (V*b)* noted. The swelling capacity was computed with Equation (10).

$$\text{Swelling capacity} = \frac{\text{Vb} - \text{Va}}{\text{Va}} \times 100 \quad (10)$$

2.2.3. FTIR characterization

FTIR analysis of the cellulose powder was carried out using FTIR-4100 Spectrophotometer (Shimadzu Co. Japan). Using the potassium bromide (KBr) tablet method, 5 mg of the powder was blended with potassium bromide to give a 200 mg weight powder. The powder was compressed using a Sigma KBr press into a tablet, and then placed in the sample compartment of the spectrophotometer and scanned at a range of 4000 - 1000 cm^{-1} (Lokshina et al., 2015).

2.2.4. Preparation of directly compressed cellulose tablets

Cellulose powders were directly compressed into three batches of tablets using a single punch tableting press (Koln Niehi, Germany) at compression pressure of 8.0, 8.1 and 8.3 MPa. Tablets weighing 500 mg were uniformly compressed and kept in air tight containers until evaluation.

2.2.5. Evaluation of tablets

The compressed tablets were subjected to the following tests using standard procedures: tablet dimensions, weight uniformity, tensile strength, friability, porosity, swelling index, moisture sorption and disintegration time (British Pharmacopeia, 2009).

2.2.5.1. ***Dimensions***

A micrometre screw gauge (Gallenkamp) was used to measure the thickness and diameter of each of ten tablets per batch and their mean values recorded.

2.2.5.2. ***Weight uniformity***

Twenty tablets from each batch were used for the test. The weight of each tablet was determined and the mean or average weight and standard deviation was computed.

2.2.5.3. ***Friability***

Pre-weighed tablets (10) were placed in the drum of a friabilator (Erweka GmbH, Germany) revolving at 25 rpm. After 4 min, the tablets were brought out, de-dusted and reweighed. Friability was calculated as the percentage loss in weight.

2.2.5.4. ***Tensile strength***

Using a motorized tablet hardness tester (Campbell Electronics, Model HT-30/50, India), the crushing strength of ten individual tablets per batch was determined by diametric compression and applying Equation (11) (Fell and Newton, 1970), the tensile strength in MN/m^2 was calculated.

$$\text{Tensile strength} = \frac{2F}{\pi dh} \tag{11}$$

Where F = force in MN needed to cause diametral tensile failure or breaking force, d = tablet diameter in m, h = tablet thickness in m.

2.2.5.5. ***Tablet porosity***

The porosity of the cellulose tablet compresses per batch was calculated by applying Equation (12).

$$\text{Tablet porosity} = 1 - \frac{4W}{\pi d^2 hDt} \tag{12}$$

Where W = tablet weight, d = tablet diameter in m, h = tablet thickness in m, Dt = true density of cellulose powder

2.2.5.6. ***Moisture sorption ratio and swelling index***

Tablets of similar porosity were used for the test. The weights and dimensions (diameter and thickness) of 10 tablets per batch were measured and the tablet exposed to ambient atmospheric temperature and humidity for 12 days. The differences in the tablet weights and dimensions after the period was used as a measure of the tablets moisture sorption ratios and swelling indices respectively.

2.2.5.7. ***Disintegration time***

The time taken for six tablets per batch to disintegrate in distilled water at 37 ± 0.5 °C were determined using the British Pharmacopeia tablet disintegration unit apparatus (Type MK IV, Manesty Machines Ltd, Liverpool, England). Their mean or average times and standard deviation were computed.

2.2.5.8. ***Statistical analysis***

The mean values obtained from the evaluation of the cellulose powder compresses were subjected to student's t-test at 5 % level of significance using GraphPad InStat 3.10.

3. RESULTS AND DISCUSSION

3.1. Powder Properties

Some of the organoleptic and physicochemical properties of the cellulose powders are shown in Table 1. The powders were white in colour, tasteless, odourless and gritty in texture. They were insoluble in water at ambient temperature and they showed absence of starch, reducing sugar and lignin but showed the presence of cellulose. These results are similar to those obtained by other workers from the organoleptic and chemical tests on cellulose powder from cassava fermentation waste, cotton and sawdust (Eraga et al., 2015; Ohwoavworhua and Adelakun, 2005; Oyeniyi and Itiola, 2012).

Table 1: Some properties of the cellulose powders

Properties	Cellulose powder	
	White Maize	Yellow Maize
Appearance	White	White
Taste	Tasteless	Tasteless
Odour	Odourless	Odourless
Texture	Gritty	Gritty
Solubility (30 °C)	Insoluble	Insoluble
Presence of starch and sugar	Negative	Negative
Presence of lignin	Negative	Negative
Presence of cellulose	Positive	Positive
Bulk density (g/cm^3)	0.469	0.476
Tapped density (g/cm^3)	0.821	0.666
Carr's index (%)	42.87	28.54
Hausner's ratio	1.75	1.40
True density (g/cm^3)	1.71	1.71
Porosity	0.73	0.72
Flow rate (g/sec)	2.90	2.96
Angle of repose (°)	46.62	39.92
Hydration capacity (%)	4.95	4.25
Moisture content (%)	2.20	2.10
Swelling capacity (%)	78.65	85.40
α-cellulose yield (%)	4.43	4.21

The bulk and tapped density values of the cellulose powders showed a higher powder consolidation for the white maize powder even though both powders seemed to have similar and comparable true density, porosity and flow rate values. This difference could be attributed to the cellulose powder particle shape and size distribution. Despite the fact that both powders were screened through the same sieve size, it does not translate into same shapes and size distribution (Emenike et al., 2016). However, the bulk densities of the powders in relation to their tapped densities implies that the maize chaff cellulose has good compressibility. Their true densities also support this inference (Shah et al., 2008). True density is a more reliable determinant of compressibility, since it is intrinsic to a material whose characteristics are being determined; this is unlike bulk and tapped densities, which depend on factors such as tapping and vibration whose intensity may vary from person to person (Saw et al., 2013).

The Hausner ratios, Carr's indices, angles of repose and flow rate (Table 1) values of the cellulose powders indicated that the powders had fair to poor flow properties with the yellow maize chaff cellulose exhibiting superior flow properties over the white maize chaff cellulose. This finding would suggest that the yellow maize chaff cellulose is less cohesive and this could be due to its larger particle size, less asperities and hence a lower degree of particle-particle interaction (Castellanos, 2005). Previous studies have also shown that the cellulose powders on its own is poor flowing and the inclusion of glidant, to facilitate flow when used in formulation is recommended (Achor et al., 2014; Eraga et al., 2015).

Hausner's ratios of powders are indicators of the level or extent of densification that could result from feed hopper vibration in the process of tablet die filling and tableting. With the uniformity of powder flow into tablet dies adversely affected by densification, the uniformity of the tablet weight and content of active (drug) may also be affected adversely. A high Hausner's ratio indicates a significant densification of powders (Shah et al., 2008).

The cellulose powders exhibited hydration capacities of 4.95 and 4.26 %, moisture contents of 2.20 and 2.10 %, swelling capacities of 78.65 and 85.40 % and α-cellulose yields of 4.43 and 4.21 % for the white and yellow maize chaffs respectively. The hydration capacity results showed that the cellulose from the chaff of both maize species are highly hydrophilic, absorbing about 5 times their own weight of water. The swelling indices of the celluloses indicate that the change in volume due to absorption of water was very high. The low yield values of the extraction process when compared to that of groundnut shell (21 %), rice husk (23.1 %) (Okhamafe et al., 1991) and cassava fermentation waste (48 %) (Eraga et al., 2015), could lead one to discount this source of cellulose. As a waste material from starch production, the cellulose extracted would be an added economic value to the starch production process and the waste processing is much easier than the other aforementioned sources of cellulose. Also the swelling capacity values would suggest that the cellulose powder would be a good candidate as a disintegrant.

3.2. FTIR Characterization

The FTIR spectra of the cellulose powders from white maize chaff (Figure 1 (line a)) and yellow maize chaff (Figure 1 (line b)) showed very similar and comparable patterns. The spectra exhibited four major peaks at 3396.64, 2902.87, 1627.92 and 1060.85 cm^{-1}. The absorption band at 3444 - 3396 cm^{-1} would imply presence of a large number of various types of hydrogen bonds formed by -OH groups while the band at 2904 - 2902 cm^{-1} reveals the symmetric and asymmetric vibrations of -CH_2 groups. Deformational vibrations of -C-O-H, -CH_2 and -CH groups are located in the absorption bands at 1647 - 1327 cm^{-1}. Intensive bands in the field 1060 - 1060 cm^{-1} are characteristic for cyclic monosaccharides and correspond to valent vibrations of C-O and the C-C ring structures. These four characteristic absorption bands of the cellulose powders are in line with and comparable to the absorption bands of the FTIR spectrum of cellulose extracted from cotton in a similar study by Lokshina et al. (2015).

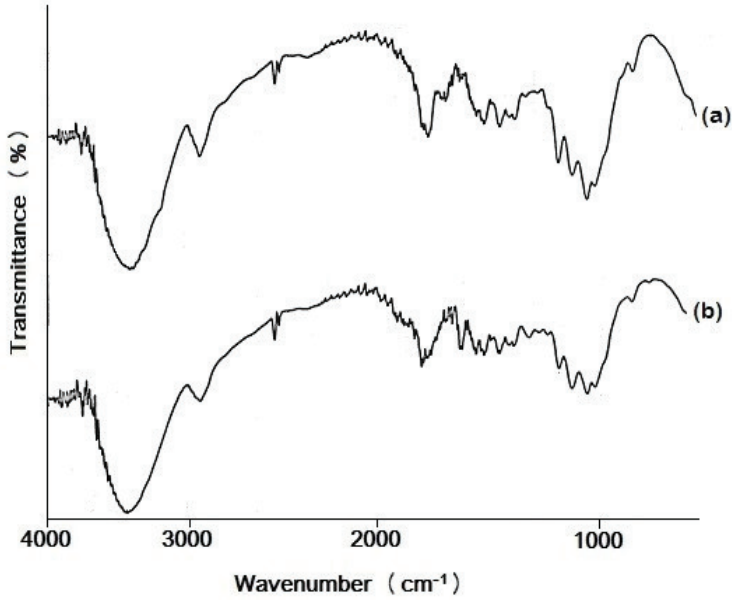

Figure 1: FTIR spectra of the extracted cellulose powders from white (a) and yellow (b) destarched maize chaff

3.3. Tablet Properties

The results from the evaluation of the cellulose tablets at different compression pressures are presented in Tables 2 and 3. There were slight deviations, though insignificant from the tablets' mean diameter and thickness. The weight of the tablets ranged between 496 - 499 mg and the tablet weight variations were not more than ± 4 % of the calculated average weights. The percentage friability of the cellulose tablets was between 0.70 - 0.79 %. The crushing and tensile strength values of the tablets were between 3.28 - 4.45 kp and 3.04 - 4.12 N/m^2 respectively, with the highest values seen in the batch of tablets compressed at 8.3 MPa. The hardness of all the tablets was not satisfactory, as crushing strength values greater than or equal to 4 kp are considered optimal and acceptable (Rudnic and Schwartz, 2000). Increase in the compression pressure resulted in a corresponding increase in the tablets hardness and a decrease in friability. This increase in hardness and a decrease in friability would imply that the cellulose powders have good compression and binding properties. With the increase in compression pressure, there may have been an increase in bond formation between the powder particles as a result of plastic and elastic deformation and asperity melting of the particles during compaction (Zhang et al., 2003; Musa et al., 2008).

Table 2: Some physical characteristics of the cellulose powder compresses

Cellulose	Batch	Compression pressure (MPa)	Dimensions (cm)		Weight (mg)	Friability (%)	Crushing strength (kp)	Tensile Strength (N/m^2)
			Diameter	Thickness				
White maize	A	8.0	1.51 ± 0.01	0.39 ± 0.01	498 ± 1.20	0.79 ± 0.11	3.286 ± 0.082	3.04 ± 0.02
	B	8.1	1.51 ± 0.02	0.39 ± 0.01	496 ± 1.40	0.74 ± 0.05	4.346 ± 0.064	4.02 ± 0.01
	C	8.3	1.51 ± 0.01	0.39 ± 0.01	497 ± 1.80	0.70 ± 0.02	4.454 ± 0.102	4.12 ± 0.11
Yellow maize	D	8.0	1.51 ± 0.01	0.39 ± 0.01	495 ± 1.10	0.77 ± 0.05	3.286 ± 0.032	3.04 ± 0.02
	E	8.1	1.51 ± 0.03	0.39 ± 0.01	499 ± 1.50	0.75 ± 0.10	3.676 ± 0.022	3.40 ± 0.02
	F	8.3	1.51 ± 0.02	0.39 ± 0.01	498 ± 2.00	0.72 ± 0.01	3.913 ± 0.054	3.62 ± 0.16

Mean ± standard deviation

Table 3 shows that the tablets exhibited a negligible increase in porosity with increase in compression pressure (values ranged from 0.599 - 0.604), while the tablets' swelling indices and moisture sorption capacities were not affected by the compression pressure. The yellow maize chaff tablets showed a marginally lower swelling indices of 27.50 - 27.60 % over the white maize chaff tablets with values of 28.20 - 28.40 %. On the other hand, the white maize chaff tablets with moisture sorption values of 37.34 - 37.43 % were also slightly higher than those of the yellow maize chaff tablets (36.20 - 36.25 %). Additionally, all the cellulose tablets disintegrated within 11 sec and the disintegration time increased as the tablets compression pressure was increased. The statistical difference of the mean values of these tablet parameter of both maize chaff tablets were not significant ($p > 0.05$) at the various compression pressures. This non-significant differences suggests that both maize chaff cellulose powders used in the tablet formulation exhibits comparable compressibility properties.

Table 3: Some physicochemical characteristics of the cellulose powder compresses

Cellulose	Batch	Compression pressure (MPa)	Porosity	Swelling index (%)	Moisture sorption (%)	Disintegration time (sec)
White maize	A	8.0	0.599 ± 0.001	28.24 ± 0.22	37.43 ± 0.32	7.8 ± 0.25
	B	8.1	0.599 ± 0.002	28.20 ± 0.54	37.42 ± 0.20	9.5 ± 0.34
	C	8.3	0.601 ± 0.001	28.20 ± 0.15	37.34 ± 0.50	9.5 ± 0.61
Yellow maize	D	8.0	0.602 ± 0.002	27.50 ± 0.44	36.20 ± 0.15	9.3 ± 0.19
	E	8.1	0.604 ± 0.001	27.60 ± 0.46	36.25 ± 0.24	10.6 ± 0.71
	F	8.3	0.603 ± 0.001	27.60 ± 0.11	36.21 ± 0.54	10.2 ± 0.62

Mean ± standard deviation

Results of the swelling indices, moisture sorption and porosity tests of the cellulose tablets would indicate that tablets with greater void spaces or pores in their structure facilitated significant water uptake and effective swelling of the primary particles of the tablet. This fact was further collaborated by the short disintegrating times of the tablets. However, the increase in disintegration times with increase in compression pressure could be attributed to reduced liquid penetration into the tablet structure as a result of the tablet's increased hardness (Mariais et al., 2003).

4. CONCLUSION

This study has shown that the extracted α-cellulose from both the white and yellow maize chaff exhibits comparable physical and chemical properties. Their tablet formulations at different compression pressures also showed comparable tableting properties, hence the obtained α-cellulose powders can be used interchangeably as a direct compression excipient in solid dosage forms because of their high compression and binding ability.

5. ACKNOWLEDGMENT

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6. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

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