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Evaluation of cellulose obtained from maize husk as compressed tablet excipient

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ABSTRACT

Cellulose derived from Zea mays husk has been investigated as a disintegrant in a metformin tablet formulation in comparison with microcrystalline cellulose and cornstarch BP. The cellulose, extracted from Zea mays husk by a two stage sodium hydroxide treatment process followed by bleaching with sodium hypochlorite was incorporated extragranularly in metformin tablet formulation. The mechanical properties of the tablets were assessed using crushing strength and friability tests, while the drug release properties of the tablet were evaluated using disintegration and dissolution times as assessment parameters. Maize husk cellulose has fairly good flow, absorbs at least two times its weight of water and has comparable hydration capacity to microcrystalline cellulose and cornstarch. Tablets containing higher concentrations (5.0 %w/w and above) of maize husk cellulose generally conformed to official standard by showing friability values of 1% or less. Tablets formulated with maize husk cellulose had comparable mechanical strength to tablets made from cornstarch and microcrystalline cellulose. Metformin tablets containing maize husk cellulose disintegrated within 5 minutes at all concentrations and showed significantly ($p< 0.01$) lower values of disintegration times than those of cornstarch and microcrystalline cellulose. The disintegration time generally decreases with increased concentration of the maize husk cellulose while T_{50} and T_{80} increase with increased disintegrant concentration. The results suggest that maize husk cellulose could be useful as an alternative disintegrant to produce tablets with particular mechanical strength and drug release profile

Keywords: *Zea mays*, cellulose, disintegrant, mechanical and release properties.

INTRODUCTION

Cellulose is the backbone of structure of plants and it is the chief constituent of plant cell wall. It is the most widely used organic material in the world, with a worldwide consumption that is higher than steel, coal or sugar [1]. Various natural fibers such as cotton and higher plants have cellulose as their main constituent. It consists of long chains of anhydro-D-glucopyranose units (AGU) with each cellulose molecule having three hydroxyl groups per AGU, with the exception of the terminal ends. Cellulose is insoluble in water and most common solvents [2]; the poor solubility is attributed primarily to the strong intramolecular and intermolecular hydrogen bonding between the individual chains. In spite of its poor solubility characteristics, cellulose enjoys extensive use in the pharmaceutical industry as diluents, lubricants, disintegrants, binders and coatings in the manufacture of tablets and capsule. In general, the sources of cellulose especially for pharmaceutical uses, are woods from plantations specially grown for the purpose in the temperate region. The sources are thus expensive. In view of the highly limited financial resources available to developing countries, which are largely located in the tropics, attention have shifted to

examining agricultural wastes as sources of cellulose. A survey of the literature shows that cellulose have been isolated from wood, saw dust [1, 3, 4] and more recently from zea mays husk [5].

Zea mays (Maize) is an annual plant growing to 2 m (6ft 7in) at a fast rate. It is in flower from July to October, and the seeds ripen from September to October. The flowers are monoecious and are pollinated by wind. Maize, like all plants, is a multicellular eukaryote with cellulose made cell walls. Maize plants have two different inflorescences, or cluster of flowers, these differ with the gender of the inflorescence. The female inflorescence is the most familiar part of the maize plant as it bears the fruit of the plant and is used for animal and human consumption. The female inflorescence, called the ear, has five parts, the kernel, the husk leaf, the cob, the shank, and the silk. The kernel is the seed-bearing structure of the maize plant while the husk leaf is the outer protection of the ear, it protects the kernels of the ear. The silk is the narrow elongated part of the pistil between the ovary and the stigma of a maize floret.

The role of excipients in determining the quality of a formulation and in many cases the bioavailabilty of a drug from tablets has received considerable attention in recent years and disintegrants play a significant role in this regard. Since a tablet is not useful until its active component is made available for absorption, the disintegrant is arguably the most important excipient in a tablet. Various locally sourced materials (starches, celluloses and clays) have been investigated as potential disintegrants in various tablet formulations [6, 7, 8, 9] but it appears no work has been done on evaluating the disintegrant ability of cellulose derived from maize husk. Hence, this study is aimed at investigating the disintegrant activity of maize husk cellulose and evaluates it as a dissolution aid in compressed tablets.

MATERIALS AND METHODS

Extraction of cellulose

The extraction of cellulose was done by a modification of the method of Okhamafe *et. al.*, 1991. The maize husk was sun dried for seven days. The sun drying was done between 9:00 hrs and 16:00 hrs daily. The average temperature during this period was 33 ^{o}C and the relative humidity was 67 %. The sun dried husk was then size reduced using a mill. A 200g of the powdered maize husk was treated with 100 mL of a 2 %w/v of sodium hydroxide to delignify the plant material for thirty minutes. The resulting slurry was filtered using whatman filter No.1 paper and the residue on the filter paper was further treated with 500 ml of 17.5 %w/v of sodium hydroxide to digest the powdered materials at 80°C for 1 h. The resulting slurry was filtered and the residue was thoroughly washed with distilled water and further treated with 3.2%w/v of sodium hypochlorite for 20 min at 80 °C to bleach the residue. The residue was further washed with 5 litres of distilled water until the residue was neutral to litmus paper. The cellulose material was filtered and the water manually squeezed out to obtain small lumps, which was dried at 60°C for 6 hr and labeled MHC.

Evaluation of Physicochemical Properties of Powders

The static angle of repose was measured according to the fixed funnel and free standing cone method using the method adapted by Iwuagwu and Onyekwelli (2002). A funnel was clamped with its tip 2 cm above a graph paper placed on a flat horizontal surface. The powders were carefully poured through the funnel until the apex of the cone thus formed just reached the tip of the funnel. The mean diameters of the base of the powder cones were determined and the tangent of the angle of repose. The flow rate was calculated as the ratio of the mass of the samples to their time of flow. The particle density was determined by the pycnometer method using the liquid immersion technique with benzene as the displacement fluid. The bulk density of each powder at zero pressure (loose density) was determined by pouring the powder at an angle of 45^{0} through a funnel into a glass measuring cylinder with a diameter of 21 mm and a volume of 50 mL [11]. Determinations were made in triplicate. Tap density was determined by subjecting the powder in a graduated cylinder to 300 taps by a standardized tapping procedure of 38 taps per minute [12]. The Hausner's ratio was determined as the ratio of the initial bulk volume to the tapped volume. The hydration and swelling capacities were determined using previously reported established methods [5].

Tablet Preparation and Evaluation

Tablet Compression

Batches (500 mg) of metformin formulations containing 50 % w/w metformin powder, 2.5 % - 7.5 % w/w disintegrant [maize husk cellulose(MHC), corn starch (CS) and microcrystalline cellulose(MCC)], 5 % w/w

polyvinylpyrollidone (PVP) and 30 – 42 % w/w lactose were compressed for 30 seconds into tablets at pre-determined loads using a hydraulic hand press (Model C, Carver Jnc., Menomomee Falls, WI) fitted with a pressure gauge reading up to 2.0 metric tons. Before each compression, the die and punches were lubricated with a 2 % dispersion of magnessium stearate in 96 % ethanol. The upper punch was placed in position and the assembly positioned on the hand press. The pressure was maintained at the pre-selected compression pressure for 30 seconds and the tablet was carefully ejected and removed. The tablets prepared were stored in air-tight container over silica gel for 24 hours to allow for elastic recovery and hardening

Determination of Tablet crushing strength

The load required to diametrically break the tablet (crushing strength) was determined at room temperature using a Monsanto Hardness tester. The method and apparatus were as described in British Pharmacopoieia (BP, 1998). Ten tablets, randomly selected from each batch were used in the test. Each tablet was held between a fixed anvil and a moving jaw apparatus unti the tablet just fractured. The value of the load on the guage at this point gives a measure of the tablet crushing strength in Kilogram force (KgF). The crushing strength values were converted to Newton by multiplying by 9.8 (1kg=9.8N). Determinations were made in quintuplicate for each batch of the tablet tested.

Determination of tablet friability

The Percentage Friability of the tablet was determined using the Veego tablet friability apparatus (Veego Scientific Devices, Mumbai, India). The weights of 10 tablets were taken and then placed in the friabilator which was then operated for 4 minutes at 25 revolutions per minute. The tablets were collected, dusted and weighed again. The percentage weight loss was calculated as the friability. Determinations were made in duplicate.

Disintegration Test

The disintegration time, of the tablets were determined in distilled water at 37± 0.5C using BP Manesty disintegration test unit (Manesty Machines, Poole, U.K). Six tablets from each formulation were placed on the wire mesh just above the surface of the distilled water in the tube and the apparatus was started simultaneously. The tablets were kept in contact with the distilled water contained in the tube. The time taken for all the tablets to disintegrate and go through the wire mesh was recorded. Determinations were made in triplicate.

Dissolution Test

The rate of dissolution of metformin from the tablets was studied in a rotating basket BP Apparatus II (BP, 1998) operated at 100 rpm using a Veego Digital tablet dissolution test Apparatus (Veego, India). The dissolution medium was 900 mL of 0.68%w/v potassium dihydrogen orthophosphate at 37± 0.5 ^{o}C. Five (5 mL) samples were withdrawn at specified time intervals and immediately replaced with 5 mL samples of the fresh dissolution medium maintained at the same temperature. The amount of metformin in each sample was analysed spectrophotometrically at 233 nm on a SP6-450 UV/VIS spectrophotometer (Pye Unicam, Middlesex, England). Determinations were made in triplicate.

RESULTS AND DISCUSSION

Physicochemical properties of Maize husk cellulose

The physicochemical properties of pharmaceutical materials are dependent on various factors, and go a long way in affecting the final formulation. The physicochemical characterization obtained for the samples are presented in Table 1.

Table 1: Physicochemical characterization of Powder samples

Physicochemical properties	MHC	CS	MCC
Particle density (g/ml)	0.572	0.569	0.580
Bulk density (g/ml)	0.139	0.271	0.235
Tapped density (g/ml)	0.199	0.513	0.457
Angle of repose (°)	40.10	43.00	35.80
Flow rate (g/s)	6.09	6.83	6.04
Hausner's ratio	1.43	1.89	1.95
Hydration capacity	1.40	2.20	1.83
Swelling capacity	1.04	0.73	0.67

***MHC:** Maize husk cellulose **MCC:** Microcrystalline cellulose **CS:** Corn starch*

The particle density is the true density of the material excluding voids. From the result, the rank order of the particle density was MHC > CS > MCC. α- cellulose derived from maize husk had a relatively low bulk density which indicates an increase in the fill volume of the die during tabletting. High value of bulk density is always an advantage in tabletting because of a reduction in the fill volume of die. The angle of repose, Hausner's ratio and compressibility index are indirect measurements of powder flowability [4]. As a general guide, powders with angles of repose greater than 50^0 have unsatisfactory flow properties, whereas minimum angles close to 25^0 correspond to very good flow properties. Table 1 show that microcrystalline cellulose has the best flow while maize husk cellulose possesses fairly good flow. Microcrystalline cellulose has higher swelling capacity than cornstarch and microcrystalline cellulose and it is capable of absorbing at least two times their own weight of water and swelled considerably. This implies its rate of water uptake and the extent of water retention is higher than that of corn starch and microcrystalline cellulose.

Mechanical Properties of Formulated Tablets

Crushing strength and friability ratio are important tests for pharmaceutical tablets that often form part of a manufacturer's own specifications. Friability is especially important because the tablets are likely to be subjected to various abrasive motions during production and subsequent use. There are now requirements for these tests in the British Pharmacopoeia but with no clear limit for acceptance or rejection of tablet batches. In general, conventional compressed tablets that lose less than 1% of their weight during the friability test are usually considered acceptable.

Table 2: Crushing strength (CS), Friability (F), and CSF values for Metformin tablets containing various disintegrants.

Disintegrant	Conc. (%w/w)	Crushing strength (N)	Friability (%)	CSF
MHC	1.5	81.33	1.42	79.74
	2.5	78.77	1.30	60.59
	5.0	77.71	0.89	87.32
	7.5	71.11	0.82	86.72
	10.0	66.02	0.95	69.50
MCC	1.5	75.54	1.11	68.05
	2.5	75.23	0.95	79.19
	5.0	56.42	0.76	74.24
	7.5	81.91	1.04	78.76
	10.0	99.55	1.32	75.42
CS	1.5	72.59	1.10	65.99
	2.5	83.78	0.82	102.17
	5.0	76.03	0.62	122.63
	7.5	70.74	1.56	45.35
	10.0	69.65	1.10	63.32

According to the USP, the standard specification for the crushing strength of tablets is 40-100N.Table 2 shows that none of the tablets deviated from this standard range. Tablets formulated with maize husk cellulose in concentrations above 5% w/w generally are less friable while tablets containing low concentrations of cornstarch and microcrystalline cellulose gave friability values above 1%. The CSF measures the strength and the weakness of tablets, thus the CSF can be used as a measure of the mechanical strength of tablets. The higher the value of CSF, the stronger the tablet. Metformin tablets containing maize husk cellulose had comparable CSF values to those formulated with microcrystalline cellulose and cornstarch. The rank order of the tablet strength for tablets formulated with maize husk cellulose was 5% w/w MHC > 7.5% w/w MHC > 1.5% MHC >10.0% w/w MHC. However, metformin tablets containing 2.5% w/w and 5.0% w/w cornstarch gave tablets with better mechanical strength.

Release Properties of Formulated Tablets

In the context of tablet technology, disintegration implies penetration of the tablet by an aqueous liquid, disruption of internal bonds and the subsequent breakdown of the tablet. It has been described as the net outcome of adhesive and disintegrating forces [14]. When tablets are wetted, the disintegrating forces are activated. The British Pharmacopoeia, 1998 states that all uncoated tablets must disintegrate within 15 minutes.

Table 3: Values of D(min), T_{50} and T_{80} for Metformin tablets containing various disintegrants at different concentrations

Disintegrant	Conc. (%w/w)	D (min.)	T_{50} (min.)	T_{80} (min.)
MHC	1.5	3.7	1.0	15.0
	2.5	3.5	2.0	18.0
	5.0	2.8	2.5	33.0
	7.5	2.8	4.0	45.0
	10.0	2.1	6.0	65.0
MCC	1.5	6.0	1.0	15.0
	2.5	7.8	1.9	30.0
	5.0	8.1	2.0	32.5
	7.5	8.5	3.0	50.0
	10.0	9.0	3.0	50.0
CS	1.5	6.0	1.0	15.0
	2.5	4.7	2.0	15.0
	5.0	4.5	2.0	30.0
	7.5	4.2	2.0	48.0
	10.0	2.7	2.8	50.0

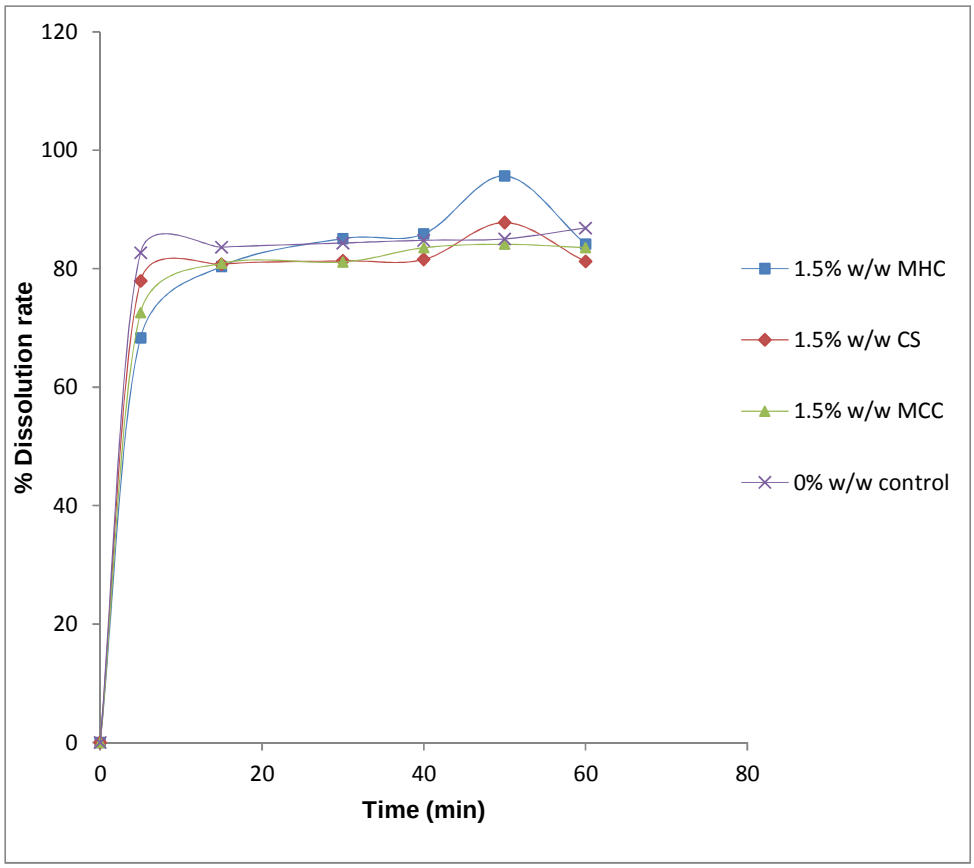

Figure 1: Dissolution profile of Metformin formulations containing 1.5% w/w MHC, 1.5% w/w CS and 1.5% w/w MCC

The results presented in Table 3 reveals that metformin tablets containing maize husk cellulose disintegrated within 5 minutes at all concentrations and showed significantly ($p< 0.01$) lower values of disintegration times than those of cornstarch and microcrystalline cellulose. This may probably be due to the higher hydration and swelling capacities of maize husk cellulose which is reflective of the ability to hold large amount of water in the pores of the powder and possibly produce tablet disintegration by two mechanisms: capillary or wicking due to interparticulate water and swelling. [5]. The disintegration time generally decreases with increase concentration of the disintegrant for formulations containing cornstarch and maize husk cellulose but the reverse is the case for formulations containing microcrystalline cellulose. Figure 1 shows the dissolution profile of metformin tablet formulations containing 1.5 %

w/w disintegrant. The release parameters shown in Table 3 indicate that only tablets containing 2.5 % w/w and 5.0 % w/w maize husk cellulose released 80 % of their drug contents within 30minutes. The time taken for 50 % and 80% (T_{50} and T_{80} respectively) drug dissolution generally increased with increased disintegrant concentration. Furthermore, tablets containing maize husk cellulose had comparable T_{50} and T_{80} to tablets formulated with cornstarch and microcrystalline cellulose

CONCLUSION

The results show that maize husk cellulose can be suitably employed as a disintegration aid and may be a suitable alternative to corn starch B.P and microcrystalline cellulose in tablet formulation and production.

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REFERENCES

[1] MA Iwuagwu; YI Eba; AA Omokhafe; JD Anozie. *J. West Afr. Pharm*., **1996**, 10, 18-24
[2] AM Bochek; *Russian Journal of Applied Chemistry*, **2003**, 76, 1711– 1719.
[3] OO Odeku; OA Itiola; *Pharm Pharmacol. Commun*., **1998**, 4, 183 – 188.
[4] FO Ohwoavworhua; IA Adelakun; *Tropical Journal of Pharm. Research,* **2005**, 4, 501-507
[5] LG Bakre; J Ajala; *Nig. J. Pharm. Sci.*, **2012**, 11,
[6] MA Iwuagwu; PC Okoli, *Pharm. World J*, **1992**, 9, 49 – 53.
[7] AS Adebayo; OA Itiola; *Pharm. Pharmacol. Commun.*,**1998a**, 4, 385-389.
[8] AO Okhamafe; A Igboechi; TO Obaseki; *Pharm. World J*., **1991**, 8, 120-130
[9] LG Bakre; KT Jaiyeoba; *Int. J. Biol. Chem. Sci.*, **2009**, 3, 448- 456
[10] MA Iwuagwu; AO Onyekweli; *Tropical Journal of pharmaceutical Research,* **2002**, 1, 29-37
[11] P Paronen; M Juslin, M; *J. Pharm.Pharmacol.*,**1983**, 35, 627-635
[12] British Standard 1469 (**1970**). British Standard Institution: London
[13] British Pharmacopoeia. (**1998**). HMSO, London; A262.
[14] LSC Wan; KPP Prasad; *Int. J. Pharm.*, **1989**, 55, 115 – 121.