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Superdisintegrant Properties of Coprocessed *Ipomoea batatas* Starch, Microcrystalline Cellulose and Lactose Monohydrate in Folic Acid Oro-Dispersible Tablet Formulations

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ABSTRACT

The superdisintegrant properties of co–processed *Ipomoea batatas* starch (IBS), microcrystalline cellulose (MCC) and lactose monohydrate (LMH) in folic acid oro – dispersible tablet formulations in comparison with sodium starch glycolate (SSG) and crospovidone (CROSPOV) were investigated. IBS was extracted by standard method of extraction, and its physicochemical properties were evaluated and compared with co – processed excipient (CPE) and physical mixture of excipients (PME). Folic acid oro – dispersible tablets were prepared by direct compression using CPE, PME, SSG and CROSPOV at concentrations of 2.5, 5.0, 7.5, 10.0 and 12.5 % and evaluated for tablet properties. Excipient – excipient and drug – excipient interactions using Fourier Transform Infrared (FTIR) were also investigated. Co – processing with MCC and LMH improved moisture sorption capacity (from 24 to 39 %) and flow properties, as revealed in the values of angle of repose (from 25.2 to 29.08^{o}) and flow rate (from 3.22 to 5.2 g/s). Oro – dispersible tablets that met the standard specifications for crushing strength (4 – 7 Kgf) and disintegration time (< 3 min) were produced. FTIR analyses revealed no interactions between excipients or between excipients and drugs. The results obtained show that in folic acid oro – dispersible tablets prepared by direct compression method, co – processing IBS with MCC and LMH converts it to a superdisintegrant that is directly compressible with high bond strength.

Keywords: Superdisintegrant, *Ipomoea batatas* starch, coprocessing, folic acid, FTIR

INTRODUCTION

One of the major challenges faced by some patients in the administration of oral solid dosage forms is difficulty in swallowing (Kaur *et al.*, 2011). This difficulty in swallowing (dysphagia) is more pronounced in children and elderly patients. Oro-dispersible tablets are developed as novel dosage form to overcome the limitation of dysphagia (Indhumathi and Rathnam, 2010; Bhardwaj *et al*., 2010).

In recent years, it has been recognized that single-component excipients do not always provide the requisite performance for optimal formulation (Block, 2009). The need for excipients with multi-functional properties has led scientists to co-process two or more excipients.

Co-processing is based on the concept of two or more excipients interacting at molecular level, the objective of which is to provide a synergy of improved functionality as well as masking the undesirable properties of individual materials. The result is a formulation with superior properties such as improved flowability and compressibility, better dilution potential, fill-weight uniformity and reduced lubricant sensitivity (Nachaegari and Bansal, 2004) or improved tableting performance such as disintegration and dissolution profile.

The formulation of oro-dispersible tablets requires the inclusion of super disintegrants,

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which are single or multi-component substances which facilitate the dispersion or break-up of tablets or capsules into smaller particles for quick dissolution at small quantities (Shiora and Panda, 2011). The co-processed multi-component-based super disintegrants have been introduced to achieve better tableting characteristics and optimize formulation properties than a single substance or the physical mixtures (Limwong *et al*., 2004)

Oro - dispersible tablets have drawn attention in pharmaceutical industries as a promising approach to deliver drugs (Ali and Kalter, 2014). An oro - dispersible tablet should compose of hydrophilic and lipophilic excipient with ability to dissolve, rapidly absorb water and swell to yield pressure for disintegration. The constituent excipients to a large extent, determine the stability of the formulation. The recommendation is storage at 25^{o}C or less in a dense packaging material, to control the humidity and moisture permeation. The performance of oro - dispersible tablets is strongly determined by disintegrants. The disintegrant must be permeable enough to allow the permeation of water molecules for the required disintegration. A careful identification and selection of a disintegrant is critical for the development and long term stability of the tablets (Kazumi *et al.,* 2009; Pahwa and Gupta, 2011).

Several research works have been conducted to explore methods of improving tableting properties in coprocessing of excipients. Some of them include: a study carried out with chitin, coprocessed with silicon dioxide (Hamid *et al*., 2010), coprocessing of maize starch and acacia gum as a direct compression excipient (Olowosulu *et al.,* 2011), Finasteride oro-dispersible tablets prepared with coprocessed excipients (Ashoor *et al*., 2013), coprocessing of cassava starch, gelatin and colloidal silicon dioxide at appropriate mixing ratio (Apeji *et al*., 2017)

This research work was aimed at investigating the super disintegrant properties of coprocessed *Ipomoea batatas* starch, microcrystalline cellulose and lactose monohydrate in folic acid oro-dispersible tablet formulations.

MATERIALS AND METHODS

Collection, Identification and Extraction of *Ipomoea batatas* Starch (IBS)

Fresh tubers of Sweet potato (*Ipomoea batatas*) (Fam. Convolvulaceae) were obtained in Zaria, Kaduna State. The tubers were identified and authenticated at the herbarium of the Department of Botany, Ahmadu Bello University, Zaria, with a voucher number 626.

IBS was extracted by standard method of extraction (Apeji *et al*., 2017). The dried starch was packed in a polythene bag and stored at room temperature until required.

Physico – Chemical Characterization of *Ipomoea batatas* Starch

The following physico – chemical properties of *Ipomoea batatas* starch, physical and co – processed mixture of excipients were studied:

Particle density: A standard and established method was adopted (Odeku *et al*., 2005). The particle density was determined using a pycnometer with xylene as the displacement fluid. An empty 50 ml pycnometer bottle was weighed (W). The bottle was filled with xylene and the excess wiped off. The filled bottle was weighed a second time (W1). The difference between W1 and W was obtained (W2). A 2 g quantity of the sample was weighed (W3) and transferred into the pycnometer bottle. The excess solvent was wiped off and the bottle was weighed again

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(w4). The particle density, Pt (g/cm^3), was calculated from equation below:

$$Pt = \frac{(w_2 \times w3)}{50\ (w_3 - w_4 + w_2 + w)}$$

Moisture sorption capacity: Two (2) grams of starch powder was weighed and uniformly distributed over the surface of a 70 mm tarred Petri-dish. The sample was placed in a desiccator containing distilled water in its reservoir (RH=100%) at room temperature and the weight gained by the exposed sample at the end of the five-day period was noted and the amount sorbed was calculated from the weight difference.

Hydration capacity: One (1) gram sample was placed in each of four 15 ml plastic centrifuge tubes to which 10 ml distilled water was added and then stoppered. The contents were mixed on a vortex mixer for 2 min and allowed to stand for 10 min and then centrifuged at 1000 rpm for 10 min on a bench centrifuge. The supernatant was carefully decanted and the sediment weighed. The hydration capacity, H was calculated as the ratio of sediment weight, W_S, to the dry sample weight, W_D:

$$H = W_S / W_D$$

Swelling rate: The swelling capacity of the powder was estimated by a standard method (Iwuagwu and Onyekweli, 2002). The tapped volume occupied by 5 g of the powder, V_X, was noted. The powder was then dispersed in 85.0 ml of water and the volume made up to 100 ml with more water. After 24 h of standing, the volume of the sediment, V_V, was recorded. The swelling capacity, (S) was computed using equation 5:

$$S = V_V/V_X$$

Bulk and tapped densities: Fifty (50) grams of powder was weighed on an electronic balance and poured into a 100 ml glass measuring cylinder at an angle of 45^0 using a glass funnel. The cylinder was dropped on a wooden platform from a height of 2.5 cm three times at a time interval of 2 sec. The volume occupied by the powder was recorded as bulk volume. The cylinder was then tapped on the wooden platform until the volume occupied by the powder became constant. This was recorded as tapped volume. The bulk and tapped densities were calculated as the ratio of weight to volume. The data generated were used in computing the Carr's index and Hausner's ratio:

Bulk Density or Tapped Density= Weight of powder/Volume of powder

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

$$\text{Hausner's ratio} = \frac{\text{Tapped density}}{\text{Bulk density}}$$

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Angle of repose: The angle of repose, θ was obtained using the funnel and stand method. A plugged glass funnel was mounted on laboratory stand at a height of 10 cm from the flat surface. Fifty grams (50 g) of the powder sample was placed in the funnel. The plug was removed and the sample allowed to flow. The height and diameter of the heap formed were noted. The angle of repose (θ) was calculated (Musa *et al*., 2008):

$$\theta = \frac{\tan^{-1}\mathrm{H}}{\mathrm{R}}$$

Where θ is the angle of repose; H is the height of the conical powder heap; R is the radius of the circular base

Particle flow rate: Fifty (50) grams of the powder was placed in an Erweka flow apparatus (Type GD7, Erweka – Apparatebau G.M.B.H Heusentamm, Germany) and allowed to flow through the funnel orifice. The time taken for the powder to flow through the orifice was noted and the flow rate was determined as the ratio of mass (g) to time (sec). The mean of three determinations were recorded.

$$\text{Flow rate} = \frac{\text{weight of powder in gram}}{\text{Timeof flow in seconds}}$$

Preparation of Co – Processed Excipient Using Co – Drying Method

A 182.66 g of IBS, equivalent to 40 % w/w suspension was weighed and dispersed in 273.99 mL of distilled water while 4.66 g of microcrystalline cellulose (MCC) was weighed and added to the IBS suspension. A 2.66 g of lactose was also weighed and added to the mixture of IBS and MCC. The content was then mixed with a stirrer for 5 min to attain a homogenous suspension and heated on a water bath thermostatically maintained at a temperature of 60 ^{o}C for 15 min with constant stirring . This was then poured on a plate and dried in hot air oven at a temperature of 60 ^{o}C for 1 h. The dried mass was passed through 1.0 mm sieve and kept for further use in a desiccator (Olowosulu *et al*., 2011).

Optimization of Temperature of Co – Processing

Physico – chemical properties such as swelling capacity, flow rate, Hausner's ratio and angle of repose of *Ipomoea batatas* starch; crushing strength, friability and disintegration time of placebo tablets of IBS compressed at various temperature of pregelatinization (45, 50, 55, 60, 65, 70 ^{0}C); of *Ipomoea batatas* starch were used to determine the optimum temperature of co – processing.

Selection and Optimization of the Composition of the Co – Processed Excipient Using Design of Experiment (DoE) Approach

Using design of experiment approach, a simple centroid (mixture) experimental design was used to select an optimized combination of the three excipients. The amount of *Ipomoea batatas* starch (IBS) was varied from 90 – 98 % while the contents of microcrystalline cellulose (MCC) and lactose monohydrate (LMH) were kept at 1 – 9 %. The effect of these three independent variables on dependent variables such as disintegration time and crushing strength of tablets was studied using Design of Experiment (DoE) approach. Ten runs made up of 10 possible combinations of materials to be co – processed (IBS, MCC, LMH) were designed by the software. A batch size of 10 g was prepared for each formulation. Placebo tablets of 200 mg each were prepared for each run. The tablets were kept for 24 h to allow for elastic recovery before evaluation of

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disintegration time and crushing strength, to determine the actual ratio / proportion to co – process for continuation of the study.

Table 1: Varied proportions of ingredients co – processed for optimization of temperature and constituent excipients

Runs	*Ipomoea batatas* native starch (%w/w)	Microcrystalline cellulose (%w/w)	Lactose (%w/w)
1	91.33	6.33	2.33
2	94.00	1.00	5.00
3	90.00	1.00	9.00
4	91.33	2.33	6.33
5	94.00	5.00	1.00
6	90.00	9.00	1.00
7	95.33	2.33	2.33
8	92.66	3.66	3.66
9	98.00	1.00	1.00
10	90.00	5.00	5.00

Fourier Transform Infra – Red (FT – IR) Studies

The Infrared spectra of folic acid, chlorpheniramine, *Ipomoea batatas* starch, lactose monohydrate, microcrystalline cellulose, Co – processed excipient and physical mixture of excipients were obtained using Fourier transform infra – red (FTIR) spectrophotometer. Initially, five milligrams of pure drugs (folic acid and chlorpheniramine), excipients (IBS, MCC and LMH), co – processed excipient and physical mixture of excipients were individually crushed with potassium bromide (KBr) to 200 mg resulting in a transparent pellet of about 1 mm thickness; a 1:1 ratio physical mixture of pure drug and co – processed excipient was made and their pellets prepared the same way as described above and analyzed with FTIR spectrophotometer (PElmer L1600401 Spectrum Two DT GS, UK) using KBr as beam splitter. The instrument was operated under dry air and scanned at spectra region of 4000 – 400 cm^{-1}.

Formulation Studies

Preparation of Oro – dispersible Tablets Formulations by Direct Compression: A batch size of 200 tablets were prepared, and five batches were made by direct compression using chlorpheniramine and folic acid as the active pharmaceutical ingredients (API) in two separate formulations. The target tablet weight was 200 mg as indicated in the formula for each formulation in Table 2. The tablets were formulated by mixing the active drug and the tested disintegrants: co – processed excipient (CPE), physical mixture of excipient (PME), sodium starch glycolate (SSG) and crospovidone (CROSPOV) in a mortar using a pestle to achieve a uniform blend for 10 min. The calculated quantities of the glidant 1.5 %, lubricant 1.5 % and adequate quantity of diluent were weighed on an electronic balance and incorporated into the powder and mixed for additional 2 min. Tablets were produced by direct compression using a single punch tableting machine (Type EKO, Erweka Apparatebau. G. M. B. H Heusentamm, Germany) fitted with 12 mm concave – faced punches and die set. Tablets were made at compression force of approximately 8 KN.

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Table 2: Formula for the Formulation of Folic Acid Oro – dispersible Tablets

Ingredient		Batch (Mg)														
	T (%)	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15
Folic Acid	2.5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Disintegrant	2.5, 5, 7.5, 10, 12.5															
CPE		5	10	15	20	25										
PME							5	10	15	20	25					
SSG/CROSPOV												5	10	15	20	25
Mannitol	Qs	184	179	174	169	164	184	179	174	169	164	184	179	174	169	164
Colloidal silicon dioxide	1.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Magnesium stearate	1.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Target weight		200	200	200	200	200	200	200	200	200	200	200	200	200	200	200

Key: CPE = Co – processed Excipient PME = Physical Mixture of components of Co – processed Excipient, SSG = Sodium Starch Glycolate CROSPOV= Crospovidone

Evaluation of Oro – Dispersible Tablet Formulations

Crushing strength: Five (5) tablets randomly selected from each batch were tested for hardness using a Monsanto hardness tester. The tablet was held between the spindle and anvil of the tester. The knob was then screwed gradually and gently until the tablet was properly fixed. The reading pointer was adjusted to zero on the scale. Pressure was applied by turning the knob until the required pressure that crushed the tablet was reached. The pressure was read at a unit of kilogram force (kgf) on the scale. The mean of five determinations on each batch was recorded.

Friability: Ten tablets were selected at random from each batch, dusted and weighed together on an electronic balance. They were then subjected to abrasive shock in a Tablet friabilator (Type TA3R, Erweka – Apparatebau – G. m. b. H Heusentamm, West Germany) operated at 25 rpm for 4 min. The tablets were dusted again and reweighed. The percentage loss in weight was determined for each batch of the tablets.

Thickness and diameter: Five (5) tablets were used to determine thickness and diameter with micrometer screw gauge (Moore and Wright Sheffield, England). The mean of five readings was calculated.

Weight variation: Twenty tablets from each batch were selected randomly and weighed individually using an electronic balance (Mettler Analytical Balance, Philip Harris Ltd., England). Their mean weights and standard deviations were determined based on an official method (B.P., 2002).

In – vitro disintegration time: Six (6) tablets were used to determine the disintegration time. This was carried out by placing a tablet in each of the six baskets fitted in the disintegration test apparatus using distilled water as disintegration medium at 37 + 0.5 ^{0}C. The time taken for each tablet to break into small particles and pass through the mesh was recorded and the mean taken as the disintegration time (Mohsin *et al.*, 2010).

RESULTS AND DISCUSSION

Physical Properties of *Ipomoea batatas* Native Starch

Ipomoea batatas starch was observed to be odourless, tasteless and dull white in colour, with a smooth texture. The percentage yield

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of starch in the experimental *Ipomoea batatas* tubers was 12 %, on a dry weight basis, while the gelatinization temperature was 60 ºC. (Table 3).

Table 3: Physical properties of *Ipomoea batatas* native starch

Properties	Result
Odour	Odourless
Colour	Dull white
Taste	Tasteless
Texture	Smooth
Yield	12 % w/w
Gelatinization temperature	60 ºC
Shape of granules	Round

The flow and swelling behaviour of *Ipomoea batatas* starch was studied at various temperatures of pregelatinisation, ranging from 45 – 70 ºC. It was observed that at 60 ºC, the flow was 5.57 g/s and swelling index was 28 %. It was concluded that oro – dispersible tablets of good integrity could be made at 60 ºC, based on the granular behaviour of the starch particles at this point (Table 4).

Table 4: Some physicochemical properties of *Ipomoea batatas* starch at various temperatures of pregelatinisation

Temperature of Pregelatinisation	Bulk Density g/ml	Tapped Density g/ml	Angle of Repose (º)	Carr's Index %	Hausner's Ratio	Flow Rate g/s	Swelling Capacity %
45 ºC	0.67	0.71	15.99	6.58	1.07	5.70	10
50 ºC	0.71	0.77	18.03	7.15	1.08	4.99	24
55 ºC	0.69	0.75	17.90	7.51	1.08	4.98	24
60 ºC	0.63	0.77	25.2	18.73	1.23	5.57	28
65 ºC	0.63	0.77	21.5	18.73	1.23	4.57	29.17
67 ºC	0.59	0.65	24.68	10.09	1.11	5.87	10
70 ºC	0.59	0.69	24.12	14.78	1.17	5.42	33.85
Ipomoea batatas Native Starch	0.67	0.91	25.2	26.62	1.36	3.22	26.92

In order to establish and predict the eventual performance of the final formulation of oro – dispersible tablets, a study of the disintegration time, crushing strength and friability was carried out on placebo tablets made from *Ipomoea batatas* starch at various temperatures of pregelatinisation of 45 – 70 ºC (Table 5). It was observed that disintegration time decreased and crushing strength increased as temperature rose from 45 – 55 ºC but anomalous behaviour was noted at 60 ºC. This showed and proved that robust oro – dispersible tablets could be produced at 60 ºC pregelatinisation temperature. High friability results displayed generally by the starch was as a result of poor compressibility and tabletability of the starch. However, co – processing of *Ipomoea batatas* starch with microcrystalline cellulose and lactose, which are directly compressible will improve its compressibility.

In order to make an informed choice among the various runs, the empirical method was used. The results of the disintegration behaviour of the various mixtures of constituents were used since the formulation would be oro – dispersible tablets. The run with the lowest disintegration time of 1.03 min was picked as the ideal proportion of the various ingredients in the powder mixture for continuation of the research. This was made up of 91.33 % *Ipomoea batatas* starch, 2.33 % microcrystalline cellulose and 6.33 % lactose monohydrate (Table 6).

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Table 5: Disintegration time, crushing strength and friability of placebo tablets prepared at various temperatures of gelatinisation of *Ipomoea batatas* starch.

Temperature of gelatinisation (°C)	Disintegration time (s)	Crushing strength (kgf)	Friability (% w/w)
45	20.5	1.32	10.5
50	15.2	1.70	11.32
55	4.6	1.74	9.18
60	12.11	1.63	7.51*
65	15.06	1.41	6.76
67	14.87	1.25	4.43
70	10.08	1.97	2.97

Table 6: Tablet properties for the experimental formulations containing different proportions of the constituent excipients involved in co – processing

Run	Constituent excipient			Tablet properties		
	IBS (%w/w)	MCC (%w/w)	Lactose (%w/w)	Disintegration time (s)	Crushing strength (kgf)	
1	91.33	6.33	2.33	70	1.83	
2	94.00	1.00	5.00	93	0.87	
3	90.00	1.00	9.00	141	2.20	
4	91.33	2.33	6.33	62	1.65	*
5	94.00	5.00	1.00	75	1.55	
6	90.00	9.00	1.00	101	1.02	
7	95.33	2.33	2.33	148	1.57	
8	92.67	3.67	3.67	134	0.90	
9	98.00	1.00	1.00	160	1.48	
10	90.00	5.00	5.00	117	1.62	

Key: IBS – *Ipomoea batatas* starch; MCC – Microcrystalline cellulose; * Formulation with lowest disintegration time

FT – IR spectroscopy is used to determine if there is molecular interaction between materials used or intended to be used in formulation. If the interaction is not chemical, no new functional groups are formed to warrant incompatibility (Silverstein *et al*., 2014). . The drug – excipient compatibility was also investigated by superimposing the spectra (Figures 1 - 3). All the characteristic absorption bands of folic acid were present in the IR spectrum of folic acid + CPE. There was no appearance of a new band as various band positions were maintained. It was observed that no new functional groups were formed as a result of chemical interaction between CPE + folic acid.

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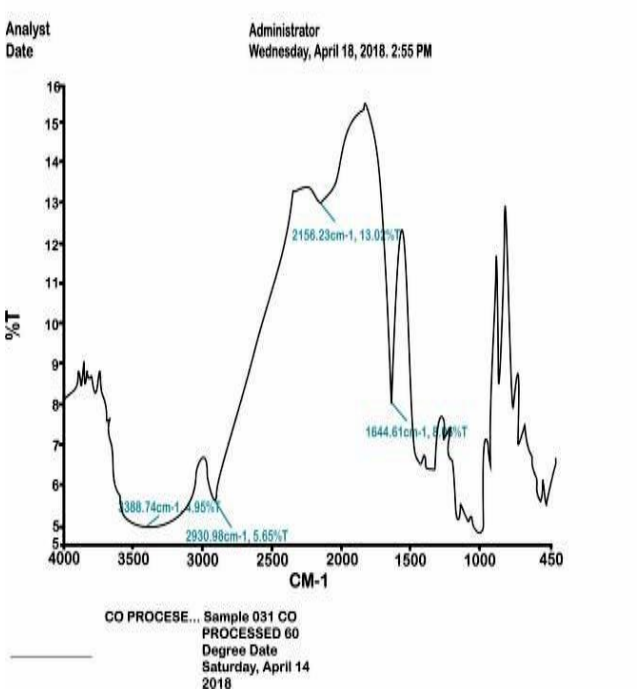

Fig. 1: FTIR spectrum of CPE

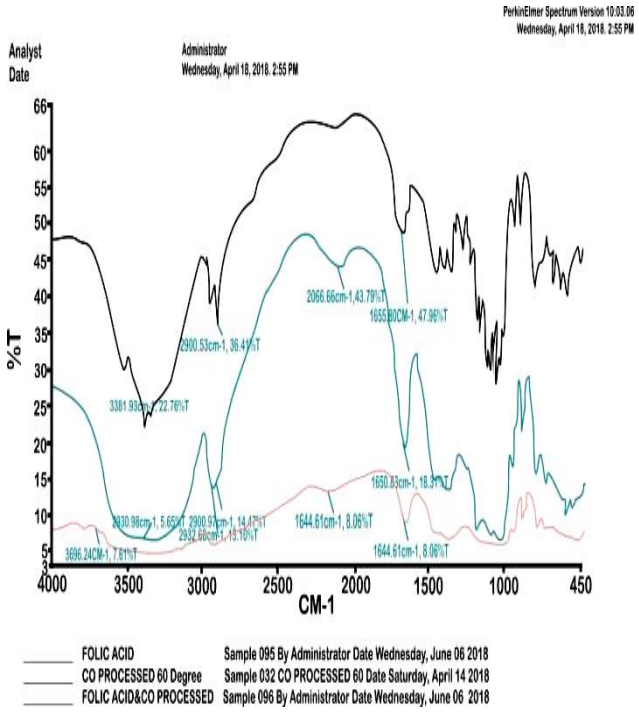

Fig. 3: FTIR spectra of pure folic acid powder, CPE powder and their mixture

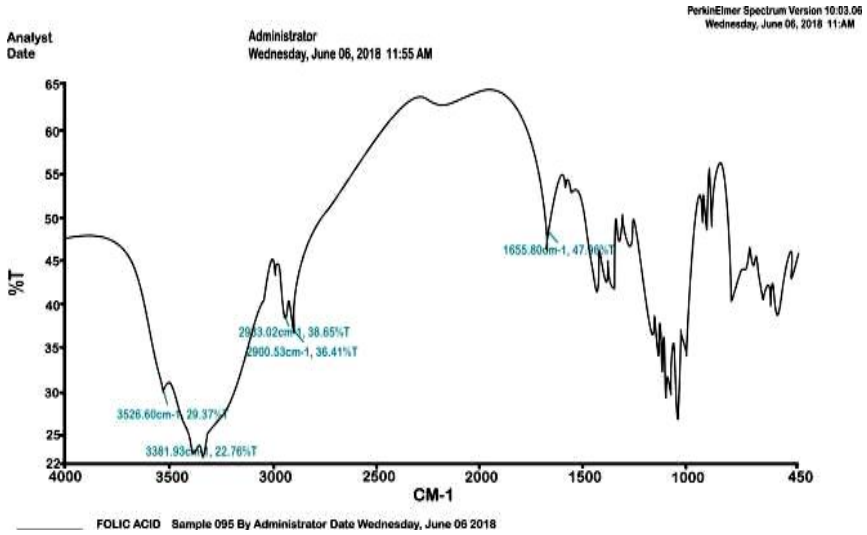

Fig. 2: FTIR spectrum of pure folic acid powder

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Swelling is an indication of tablet disintegration ability (Desai *et al*., 2016). However, this assertion is not completely true as can be seen from the results of swelling index and moisture sorption capacity (Table 7). IBS and PME had 26.92 % and 19.61 % respectively as swelling indices while CPE had -10.61. In contrast, the highest moisture sorption was observed in CPE (39 %). This has shown that there is not always direct correlation between swelling index and moisture sorption capacity. Condensation of water vapour at high RH decreased tablet strength (Coelho and Harnby, 1978). CPE was observed to have the highest moisture sorption of 39 %, compared to IBS with a value of 24 %. Co – processing must have increased the affinity of IBS for moisture by increasing the available sites of interaction through increased porosity caused by the presence of lactose monohydrate and microcrystalline cellulose within the particle structure.

Table 7: Physicochemical properties of *Ipomoea batatas* starch, physical mixture of excipients and co - processed excipient

Properties	IBS	PME	CPE
Bulk Density (g/ml)	0.67 + 0.01	0.67 + 0.02	0.58 + 0.01
Tapped Density (g/ml)	0.91 + 0.01	0.85 + 0.01	0.63 + 0.01
Angle of Repose (°)	25.2 + 1.10	38.72+ 2.02	29.08+ 1.08
Carr's Index (%)	26.37	21.18	7.94
Hausner's Ratio	1.36	1.27	1.09
Flow Rate (g/sec)	3.22+ 0.13	1.67+ 0.19	5.2+ 0.09
Swelling Index (%)	26.92	19.61	- 10.61
Solubility (%)	Insoluble	5	5
Particle Density (g/ml)	1.62	1.57	1.38
Moisture Sorption Capacity (%)	24	22	39

Key: IBS- *Ipomoea batatas* Starch; PME - Physical Mixture of Excipients; CPE - Co – processed Excipient

Results from the evaluations carried out on the different batches of the folic acid oro – dispersible tablets are shown in Table 8. Uniformity of weight is one of the characteristics of good tablets, which can be affected by powder properties and equipment (Ogaji and Okafor, 2009). Variation in weight of tablets could also indicate variation in the content of drug. According to British Pharmacopoeia (2002), the acceptable weight variation for tablets weighing more than 130 mg – 324 mg is + 7.5 %. All the batches of folic acid oro – dispersible tablets formulated with various excipients were within the allowed limits of weight variation. The oro – dispersible tablet thickness and diameter values revealed that there was no significant variation in their mean values among the batches of tablets. This could be due to the addition of lubricant (magnesium stearate) and glidant (colloidal silicon dioxide), which must have prevented die wall friction and enhanced the flow of powder blend respectively. This ensured uniform flow of powder blend into the die cavity resulting in uniform tablet diameters and thickness.

Friability is inversely related to tablet crushing strength, and measures its liability to wear and tear. Friability is a non – official test, however the British Pharmacopoeia (2002) specifies a range of 0.8 – 1.0 % loss in weight of tested tablets without capping, lamination or breaking up in the course of the test. The friability values of folic acid oro – dispersible tablets formulated with CPE, PME, SSG and CROSPOV were between 1.35 and 13.03 %. These values are higher than official specification of maximum of 1.0 %, but at

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10 % disintegrant concentrations, the experimental material, CPE gave friability values of 1.35 % for folic acid formulations. The slight deviation from 1 % could be due to low densification of CPE as a result of co – processing, to allow for fluid penetration in the formulation before oral disintegration. Chen *et al*. (2015), Dey and Maiti (2010) have reported that it is a challenge for a formulator to achieve percentage friability within limits for an orally disintegrating tablet since all methods of manufacturing of orally disintegrating tablets are responsible for increasing the percentage friability values. However, crushing strength of 6.02 Kgf for folic acid formulations was achieved, implying that robust tablets were produced at these disintegrant concentrations. It is specified that uncoated tablets should disintegrate within 15 min (British Pharmacopoeia, 2002) and oro – dispersible tablets within 3 min (European Pharmacopoeia, 2001). The main mechanisms of disintegration proposed are swelling of disintegrant resulting in development of swelling force, capillary action and annihilation of intermolecular forces resulting in development of a repulsive force between particles (Ngwuluka *et al*., 2010). Disintegration is markedly affected by formulation ingredients and processing. The study revealed that all the tablets produced passed the disintegration test. Since all the formulations were oro – dispersible tablets, the disintegration time of tablets formulated with CPE ranged from 0.45 to 3.53 min. At 10 % disintegrant concentration for folic acid formulations, disintegration time was 1.62 min, satisfying the standard requirement for oro – dispersible tablet. The fast disintegration is attributed to the amorphous content of starch which facilitates disintegration and the degree of porosity of the tablets formed.

CONCLUSION

A single – bodied, multi – component excipient was designed by co – processing together *Ipomoea batatas* starch, microcrystalline cellulose and lactose monohydrate in appropriate mixing ratio, that could serve as disintegrant for oro – dispersible tablet formulations, and compared well with commercially – available superdisintegrants (SSG and Crospovidone) in terms of performance.

Co – processing together *Ipomoea batatas* starch with microcrystalline cellulose and lactose monohydrate resulted to a directly compressible excipient, with high bond strength that can be suggested as a viable alternative superdisintegrant in the formulation of oro – dispersible tablets.

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Table 8: Post – compression parameters of Folic Acid Oro - dispersible Tablets produced with various Disintegrant Types and Concentrations

Disintegrant Concentration	Weight (g) + STD	Thickness (mm) + STD	Diameter (mm) + STD	Crushing strength (kgf) + STD	Friability (% w/w)	Disintegration time (sec) + STD	CSFR/DT
2.5 % w/w							
CPE	0.200 + 0.009	3.309 + 0.085	7.978 +0.027	3.02 + 0.87	3.32	135 + 54.92	4.46
PME	0.198 + 0.007	3.090 + 0.079	8.006 + 0.013	7.06 + 0.88	1.39	212 + 58.62	2.78
SSG	0.203 + 0.012	3.481 + 0.068	7.960 + 0.024	1.72 + 0.73	7.10	47 + 13.53	15.59
CROSPOV	0.204 + 0.007	3.267 + 0.127	7.997 + 0.029	6.34 + 2.59	1.66	56 + 36.31	11.28
5 % w/w							
CPE	0.208 + 0.007	3.436 + 0.070	8.009 + 0.022	2.96 + 0.89	3.65	122 + 32.40	5.31
PME	0.195 + 0.008	3.072 + 0.073	7.992 + 0.017	6.36 + 0.77	1.45	93 + 10.13	5.95
SSG	0.206 + 0.006	3.513 + 0.075	7.952 + 0.024	1.62 + 0.40	8.44	39 + 10.48	21.04
CROSPOV	0.194 + 0.005	3.148 + 0.083	8.019 + 0.018	5.90 + 0.90	1.43	50 + 14.68	10.12
7.5 % w/w							
CPE	0.205 + 0.009	3.173 + 0.064	8.000 + 0.019	6.02 + 0.89	1.42	194 + 69.01	2.64
PME	0.203 + 0.009	3.186 + 0.079	7.993 + 0.010	5.06 + 0.61	1.43	64 + 30.44	6.78
SSG	0.203 + 0.011	3.420 + 0.078	7.992 + 0.040	1.72 + 0.54	4.55	45 + 10.39	10.43
CROSPOV	0.198 + 0.008	3.788 + 0.126	8.112 + 0.026	2.00 + 0.42	7.70	34 + 16.99	27.18
10 % w/w							
CPE	0.200 + 0.010	3.136 + 0.092	7.998 + 0.031	5.54 + 1.08	1.35	97 + 25.32	4.63
PME	0.205 + 0.010	3.426 + 0.258	7.987 + 0.015	2.30 + 1.47	4.17	113 + 50.19	5.09
SSG	0.205 + 0.026	3.265 + 0.064	7.997 + 0.077	3.28 + 0.84	2.17	49 + 7.53	8.72
CROSPOV	0.203 + 0.006	3.967 + 0.048	8.190 + 0.014	1.32 + 0.46	8.11	32 + 10.28	20.07
12.5 % w/w							
CPE	0.202 + 0.008	3.119 + 0.091	7.996 + 0.007	6.96 + 0.62	1.50	159 + 50.52	3.97
PME	0.205 + 0.007	3.235 + 0.091	7.988 + 0.013	3.64 + 0.45	1.81	115 + 28.12	3.44
SSG	0.206 + 0.007	3.283 + 0.046	7.975 + 0.042	4.82 + 0.83	2.40	44 + 5.82	15.77
CROSPOV	0.197 + 0.007	4.171 + 0.066	8.186 + 0.050	1.20 + 0.27	13.03	27 + 6.31	34.75

Key: CPE = Co – processed Excipient
PME = Physical Mixture of Components of Co – processed Excipient
SSG = Sodium Starch Glycolate
CSFR/DT = Crushing Strength Friability – Disintegration ratio
STD = Standard Deviation

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