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ISOLATION AND RELEASE RETARDANT PROPERTIES OF A PLANT GUM OBTAINED FROM AYOYO

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ABSTRACT

Ayoyo gum is a natural gum from the leaves of the plant *Corchorusolitorius*. The gum was extracted, characterized and evaluated as a release retardant in comparison with gelatin in paracetamol tablet formulations. Compressional properties of the formulations were analyzed using density measurements. The mechanical properties of the formulations were assessed using crushing strength and percentage friability. The drug release properties of the tablets formed were assessed using disintegration and dissolution times. The yield of Ayoyo gum was within the limit. The gum showed superiority over gelatin in swelling and hydration capacities. All the tablets formulated with Ayoyo passed the compendial requirements for tablets. Tablets produced with Ayoyo gum showed higher crushing strength, friability, disintegration and dissolution times, and lower friability, at higher concentration it retarded the release of paracetamol.

Ayoyo gum can be used as a substitute to gelatin in paracetamol tablet formulations and depending on the desired onset of action of medicament Ayoyo gum may be used as a binder in formulation of sustained release tablets.

Introduction

Binders are agents used to impart cohesive qualities to the powdered material during the production of tablets. They impart cohesiveness to the tablet formulation, which ensures that the tablet remains intact after compression as well as improving the free flowing quality of granules (Gangurde*et al*, 2012)
Pharmaceutical scientists all over the world today are increasingly interested in natural drugs and excipiens because of reasons of reliability, sustainability, cost and avoiding reliance on materials derived from fossil fuel (Singh *et al*, 2010).

Gums and mucilages constitute a structurally diverse class of biological macromolecules with a broad range of physicochemical properties which are widely used for various applications in pharmacy and medicine(Malviya*et al*, 2011).
Cochorusolitorius Linn (*Tiliaceae*), commonly called "Ayoyo" in the Northern Nigeria is an annual herb with a slender stem. It is an important green leafy vegetable in many tropical area including Egypt, Sudan, India, Bangladesh, in tropical Asia such as Philippine and Malaysia, as well as in tropical Africa, Japan, the Caribbean and Cyprus. The plant is widely grown in the tropics for the viscosity of its leaves. The leaves (either fresh or dried) are cooked into a thick viscous soup or added to stew or soup and are rich sources of vitamin and minerals(Ohtani*et al*, 1995).
A number of plant gums/hydrocolloids have been used as binding, suspending or emulsifying agents in solid and liquid dosage formulations (Odeku, 2008; Emeje*et al*., 2008, 2009). The aim of the study is to extract, characterize and evaluate the release retardant of paracetamol from tablets formulated with Ayoyo.

1.1. Materials and Methods

Nutrient agar (Microstar, India), Potato dextrose agar (Microstar, India), Gelatin (BDH chemicals limited, Pooles England), Talc (BDH chemicals limited, Pooles England), Magnesium stearate (BDH chemicals limited, Pooles England), Paracetamol powder (BDH chemicals limited, Pooles England), Lactose (BDH chemicals limited, Pooles England)

1.1.1. Sample collection and identification

The leaf of Ayoyo was purchased from Gamboru market in Maiduguri, Borno state and was identified by a taxonomist in the Department of Biological Science, University of Maiduguri.

1.1.2. Extraction

The extraction method of Ahad (2011) was used. The leaves were separated from the stem and dried under the shade. The dried leaves were then milled using a milling machine(YC 100L-4 Classic England) to increase the surface area of the leaves and to enhance the extraction process as well as to enable the maximum amount of mucilage to be extracted.
The milled Ayoyoleaves was crushed and soaked in water for 5–6 h, boiled for 30 min and left to stand for 1 h to allow complete release of the mucilage into the water. The mucilage was extracted using a multi-layer muslin cloth bag to remove the marc from the solution. Acetone in the ratio 1:1 was added to precipitate the mucilage. The precipitated mucilage was separated and dried. The dried mucilage was then collected, ground, passed through a # 80 sieve. The size reduced mucilage was stored in an air tight container.

1.1.3. *Characterizationofthegums*

Organoleptic test
The colour, odour and taste of the gum extract were obtained and compared with that of gelatin.

Solubility test
One gram of gum extractwas dissolved in 2 ml of cold distilled water, hot distilled water, Acetone,Ethanol, and Chloroform and the solubility profile of the gum extract was determined and recorded.

Determination of moisture content

A 3 gweight of the gum powder was put into the moisture content analyser (Sartorious, Germany). The machine was then set to 130°C for five minutes. The value of the moisture content of the gum powder was read and recorded. The procedure was repeated twice and the mean was taken as the moisture content.

Determination of hydration capacity

The method of was Musa *et al*(2008)was adopted. One gram of the gum powder was placed in a tarred 20ml stopper centrifuge tube. The weight of the tube was noted; 10ml of distilled water was added and shaken vigorously for 2 min. It was then allowed to stand for 10 min during which it was mixed by inverting the tube three times at the end of 5 and 10 min.

The sample was centrifuged at 1000 rpm for 10 min. The aqueous supernatant was then carefully removed and the tube with the sediment was re-weighed. The hydration capacity was calculated as the ratio of the weight of the sediment to the initial weight of dry powder. The procedure was done in triplicate and the mean taken.

Determination of Swelling Power

The method of Musa *et al*(2008) was used, the tapped volumes occupied by 5g of the gum was noted. The gum was then dispersed in 85ml of distilled water and the volume made up to 100ml with more distilled water. It was allowed to stand for 24 hr. The volume of the sediment was then determined and the swelling capacity calculated from the difference in volumes.

Determination of Ash Value

A 2 g weight of each sample was placed in separate porcelain crucible and its content was placed in furnaces (Lenton,England). The content was ashed at 650^0C for 10 hr until a whitish grey matter was obtained. The samples were then removed from the furnace, cooled in a desiccator and reweighed. The percentage (%) ash was calculated using the formula;

Ash value (%) = $\frac{Wa}{Ws} \times 100$

Where Wa is weight of ash obtained,

Wsis weight of sample used.

Determination ofDensities

Bulk Density (Db): 10g of the gum powder was introduced into a clean, dry 100 ml measuring cylinder and the volume was recorded. It is expressed in g/ml and is given by,

Db = $\frac{M}{Vo}$

Where, M is mass of the gum powder.

Vo is the bulk volume of the gum powder.

Tapped Density (D*t*): 10g of the gum powder was introduced into a clean, dry 100 ml measuring cylinder. The measuring cylinder was then tapped 50 times from a fixed height of about 20mm and the tapped volume was read. It is expressed in g/ml and is given by,

Dt = $\frac{M}{Vt}$

Where, M is mass of the gum powder.

Vt is the tapped volume of the gum powder.

Angle of repose

Fifty grams of the gum powder wasplaced in a plugged glass funnel which was clamped on a retord stand at a distance of10cm from a flat surface. The powders were thenallowed to flow through the funnel orifice by removingthe cotton plug from the funnel orifice. The height of theheap (h) formed as well as the radius of the heap (r) wasnoted. The angle of repose (Θ) was calculated as:

$\Theta = \tan^{-1}\frac{h}{r}$

Hausner's Ratio

It previews the degree of densification which would occur during tableting. It is the ratio of tapped density to bulk density and calculated thus:

$$\mathbf{H} = \frac{Dt}{Db}$$

Carr's Index (CI)

The difference between the tapped and bulk density divided by the tapped density. It is expressed in % and is given by;

$$\mathbf{I} = \frac{Dt - Db}{Dt} \times 100$$

Microbial load

A 1g weight of the powdered gum was dissolved in 10ml of sterile distilled water and 1 ml of the dissolved extract was put into a universal bottle containing 9ml of sterile distilled water to make a 1:10 dilution. The diluted solution was incubated in prepared plates and the numbers of colonies formed were counted.For determination of fungal growth in the sample, potato dextrose agar medium was used. The plates were incubated at 27°C for 72 hr. Nutrient agar was used for the determination of bacterial growth and the plates were incubated at 37°C for 24 hr (BP, 2002).

1.1.4. Preparation of granules

The granules were prepared using the wet granulation method. A1, A2, A3, A4 and G1, G2, G3, G4 represent binder concentrations of 2, 3, 5 and 10 % w/v for Ayoyo and Gelatin respectively.

Table 1: Showing the working formula used in the preparation of the granules

Ingredients	Formulation							
	A1	A2	A3	A4	G1	G2	G3	G4
Paracetamol	500.0	500.0	500.0	500.0	500.0	500.0	500.0	500.0
Lactose	59.0	52.5	39.5	7.0	59.0	52.5	39.5	7.0
Maize Starch	63.7	63.7	63.7	63.7	63.7	63.7	63.7	63.7
Binder	13.0	19.5	32.5	65.0	13.0	19.5	32.5	65.0
Talc	13.0	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Mg Stearate	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3

Paracetamol powder was mixed with maize starch and lactose for 5 min. various mucilage were prepared using Ayoyo and Gelatin as binders; and were used to massed the mixed powders until a coherent mass was formed.
The coherent mass formed was then passed through a sieve size number 16 to form granules. The formed granules on a stainless tray were then dried. Extra-granular excipients, which include talc and magnesium stearate was then added prior to granule characterization.

1.1.5. Characterization of Granules

The following tests were carried out on the granules produced prior to compression into tablets using the same procedure as described earlier for the gum samples.

a. Angle of repose

b. Bulk and tapped densities

c. Moisture content

Compression of granules into tablets

The granules were compressed using a single punch tableting machine (Manesty type F_3, England) at a compression pressure of 7.5 metric tonnes. The tablets were then stored in an air-tight container for 24 hr prior to quality control tests.

1.1.6. Quality control tests of tablets

Uniformity of thickness and diameter

The Vernier caliper was used to measure the diameter and thickness of the tablets. The mean value of three (3) determinations was recorded in each batch.

Uniformity of weight test

Ten tablets were randomly selected from each batch and weighed individually. The mean weight of the tablets was then calculated and the standard deviation determined.

Crushing strength

The Erweka hardness tester (Erweka, Germany) was used in measuring the crushing strength of the tablets. Three (3) tablets were randomly selected from each batch. Each of the tablet was in turn placed between the anvil and the spindle of the hardness tester and subjected to increasing pressure by turning the knurled knob in a clockwise direction at constant rate until the tablet was crushed. The mean of the three determinations was taken for each batch.

Friability test

Twenty tablets were randomly picked from each batch and weighed accurately. They were then placed inside the drum of Erweka friabilator (Erweka, Germany) and operated for four (4) minutes at a speed of 25 rpm. Thereafter, the intact tablets were removed from the drum, dusted and weighed. The percentage loss of weight was calculated and recorded as friability value for that batch.

Disintegration test

Using BP (2002) disintegration test apparatus (Erweka, Germany), six tablets were picked at random from each batch placed in the basket individually. The water bath was thermostatically set at 37±1ºC. The time that took the tablet to disintegrate was recorded using a stop clock. The mean of five determinations was taken as the disintegration time.

Dissolution time

The USP (2007) apparatus 2 method was used throughout the study and buffered solution was used as dissolution medium. Using a dissolution time apparatus (Ewerka DT700 HH, Germany) and dissolution medium of 900ml of buffered phosphate solution thermostatically maintain at 37± 0.5ºC, a tablet picked at random from each batch was placed in a basket and then immersed in the medium. The apparatus was set to rotate at 100 rpm. A 5ml sample of dissolution medium was removed at designated time internal and replaced with an equal volume of fresh sample of dissolution medium. The withdrawn sample were filtered and appropriately diluted for spectrophotometric determinations using Beckmann Coulter spectrophotometer. The spectrophotometric assay was carried out at wavelength 243nm, and a mean value of three individual spectrophotometric readings was used for the drug estimation. All withdrawn samples were replaced with fresh dissolution medium.

RESULTS

The yield of gum obtained from the dry powdered leaves of *Corchorusolitorius*(Ayoyo) was found to be 29.18% which is a good yield. This may be due to the different methods of extraction used, geographical and breeding influences and possibly age, as the age of the plant used was not verified, but the yield was within the limit for plants that are grown and harvested within a year (Isah et al, 2008). The organoleptic properties (Table 2) showed that Ayoyo gum was green as its leaves with characteristic odour.

Table 2: Results of organoleptic tests of gums

Parameters	Ayoyo	Gelatin
Odour	Characteristic odour	Odourless
Colour	Green	Creamy
Taste	characteristic taste	Tasteless
Texture	Fine	Granular

The solubility pattern of both gums were similar (table 3), they are all soluble in hot water and insoluble in cold water, acetone and chloroform.

Table 3: Showing the solubility profile of the mucilages in different solvents.

Solvent	Gum	
	Ayoyo	Gelatin
Cold distilled water	insoluble	insoluble
Hot distilled water	Soluble	Soluble
Acetone	Insoluble	Insoluble
Ethanol	Insoluble	Insoluble
Chloroform	Insoluble	Insoluble

The Hausner ratio and Carr's Index can be used as an index for the flowability of a powder because the densification occurring during tapped density measurement is influenced by the same inter-particulate interactions which are affecting the flow of powders (Oyi*et al*, 2009).

From the results shown in table 4, Ayoyo has a Carr's index of 13.59 which signifies good flow character while gelatin has the Carr's index of 10.05 which signifies excellent flow property.

As with the Hausner'sRatio, Ayoyo has a value of 1.16 which also signifies good flow character while gelatin has a value of 1.11 which corresponds to excellent flow property.

Angle of repose is a characteristic related to inter-particulate friction or resistance to movement between particles. It is the constant, three dimensional angle (relative to the horizontal base) assumed by a cone-like pile of the powder assessed. It can also be used in evaluating the flow properties of powders.

Table 4: Physicochemical properties of the binders

Parameter	**Ayoyo**	**Gelatin**
Hydration capacity	1.42 ± 0.19	0.72 ± 0.06
Moisture content (%)	6.02 ± 0.34	6.30 ± 1.39
Angle of repose (°)	33.04 ± 0.17	27.58 ± 0.31

Ash value (%)	24.87 ± 0.31	4.86 ± 0.01
Bulk density (gcm^{-3})	0.72 ± 0.02	0.63 ± 0.00
Tapped density (gcm^{-3})	0.89 ± 0.01	0.70 ± 0.01
Carr index (%)	13.59 ± 2.27	10.05 ± 0.08
Hausner ratio	1.16 ± 0.03	1.11 ± 0.00
Swelling power (%)	70.54 ± 3.00	20.34 ± 1.14
Microbial Load (CFUs/g)		
Bacteria	149	48
Fungi	0	0

From the results in table 4, Ayoyo has an angle of repose of 33.04 which signifies good flow property while gelatin has an angle of repose of 27.58 which signifies excellent flow property. The difference between these values may be due to the difference in the particle size (texture)of the gums as shown in table 2. Fine particles are more cohesive than coarse particles and this cohesive force affects powder flow (Wells *et al*, 2007).
Swelling, which is generally accepted as an indication of tablet disintegration ability can be assessed by the determination of hydration capacity, swelling capacity and moisture sorption profile (Bakreand Jaiyeoba, 2009). The hydration capacity values obtained for Ayoyo wasgreater than that of gelatin (Table 4). Ayoyo has the hydration capacity of 1.42 which means that it is capable of absorbing about one and a half times its own weight of water ; while gelatin has a hydration capacity of 0.72 which also means that it can absorb water of more than half time its own weight.

The swelling capacity followed similar pattern to hydration capacity.Ayoyo has greater hydration capacity thanGelatin(table 4). Swelling capacity of a substance reflects the increase in volume of that substancefollowing water absorption. In addition, the relatively higher hydration and swelling capacity values that was observed with Ayoyo compared to gelatin could possibly be due to the higher powder porosity of the Ayoyo extract.Thus, if Ayoyo was incorporated in tablet formulation as a disintegrant it would probably produce tablet with low disintegration time (Bakreand Jaiyeoba, 2009).

The absorption of moisture by solid dosage forms and excipients provides information for selecting excipients and for determining the humidity control required during production and storage. The amount of moisture absorbed by drugs and excipients affects the flow, compression characteristics and hardness of tablets (Bakreand Jaiyeoba, 2009). Water interacts with pharmaceutical solids at virtually all stages of manufacture. Therefore, water – powder interaction is a major factor in the formulation, processing and performance of excipients and solid dosage forms (Bakreand Jaiyeoba, 2009).

The moisture content for Ayoyo mucilage and Gelatin are shown in table 4. Gelatin has lower moisture content and is probably less liable to microbial contamination as compared to Ayoyo mucilage although the difference between their moisture contents is not much. Also, minimum moisture content decreases tablet adhesion to the die wall and allow easy tablet ejection. It also increases the ease with which the individual particles can slip and flow during compression (Bakreand Jaiyeoba, 2009). However, it is important that the moisture content be kept as low as possible during storage to prevent microbial spoilage, hydrolysis and enzymatic decomposition.

The ash values of Ayoyo and gelatin was 24.87 ± 0.31 and 4.86 ± 0.01 respectively(table 3). Ash value according to Kar (2005), designates the presence of organic salts e.g., calcium oxalate found naturally in drugs as well as

inorganic matter derived from external sources. Therefore, it is of prime importance in the examination of the purity of powdered drugs as it reflects the level of adulteration or handling of the drug. It is also used for identification.

From the results of microbial load (table 4), there was no fungal growth in the samples of both Ayoyo mucilage and gelatin. The number of bacterial colony forming unit per gram (cfu/g) counted on both the plate having the Ayoyo mucilage and gelatin are 149 and 48 respectively. This is below the 10^4cfu/10g limit specified by USP (2007) for excipients to be used in tablet formulation. The result shows that both Ayoyo mucilage and Gelatin can be used successfully as excipients.

1.2. GRANULE CHARACTERIZATION

Table 5: Physicochemical properties of the granules with variation in concentration

Concentration (%)	2		3		5		10	
Binder	A1	G1	A2	G2	A3	G3	A4	G4
Parameter								
Moisture content (%)	1.88 ± 0.01	1.20 ± 0.10	1.48 ± 0.40	1.14 ± 0.13	1.50 ± 0.03	1.16 ± 0.17	1.35 ± 0.05	1.81 ± 0.21
Angle of repose	24.95 ± 0.2	31.08 ± 0.23	27.48 ± 0.06	25.98 ± 0.36	26.97 ± 0.67	27.39 ± 1.31	24.15 ± 0.35	30.17 ± 0.69
Bulk density	0.42 ± 0.01	0.40 ± 0.02	0.38 ± 0.00	0.41 ± 0.03	0.37 ± 0.01	0.41 ± 0.02	0.45 ± 0.01	0.37 ± 0.01
Tapped density	0.45 ± 0.09	0.48 ± 0.01	0.41 ± 0.01	0.48 ± 0.02	0.42 ± 0.01	0.49 ± 0.01	0.46 ± 0.01	0.48 ± 0.01
Carr index	5.23 ± 1.37	16.61 ± 5.28	6.55 ± 1.34	15.87 ± 4.34	12.50 ± 4.64	15.67 ± 1.45	2.9 ± 1.18	22.76 ± 2.10
Hausner ratio	1.06 ± 0.01	1.20 ± 0.74	1.07 ± 0.02	1.19 ± 0.06	1.14 ± 0.06	1.19 ± 0.02	1.01 ± 0.01	1.29 ± 0.04

Table 6: Properties of tablets formulated with different binders at different concentrations.

Concentration (%)	2		3		5		10	
Binder	A1	G1	A2	G2	A3	G3	A4	G4
Parameter								
Tablet Diameter (mm)	12.63 ± 0.15	12.50 ± 0.00	12.33 ± 0.29	12.80 ± 0.52	13.50 ± 0.00	13.00 ± 0.00	13.00 ± 0.00	12.67 ± 0.29
Tablet Thickness (mm)	5.67 ± 0.29	5.00 ± 0.14	5.77 ± 0.25	4.43 ± 0.12	5.00 ± 0.90	5.83 ± 0.29	5.33 ± 0.42	5.33 ± 0.29
Weight Uniformity (g)	0.60 ± 0.01	0.62 ± 0.02	0.62 ± 0.00	0.62 ± 0.02	0.63 ± 0.01	0.65 ± 0.01	0.65 ± 0.03	0.60 ± 0.02
Crushing strength (KgF)	3.97 ± 0.42	3.80 ± 0.40	4.23 ± 0.74	4.80 ± 0.20	5.26 ± 0.39	5.17 ± 0.25	12.22 ± 0.56	10.03 ± 0.78
Friability (%)	1.31 ± 0.16	1.77 ± 0.18	1.38 ± 0.04	0.79 ± 0.03	0.21 ± 0.16	0.25 ± 0.03	0.24 ± 0.11	0.34 ± 0.04
Disintegration Time (min)	14.27 ± 0.51	3.11 ± 0.12	15.10 ± 0.10	5.10 ± 0.15	19.50 ± 2.94	11.06 ± 0.07	40.93 ± 1.68	14.34 ± 0.16

Bulk density of a granule is primarily dependent on particle size, particle size distribution and particle shape. It is an indirect measure of granule flow and determines the die fill volume. Granules having higher bulk density require relatively lower die fill volume than those having small bulk density (Aklilu, 2002).As shown in Table 5, the bulk densities of the granules decreases with increasing concentration of binders except for Ayoyo 10%w/v, the decrease could be attributed to the increase in the proportion of larger granules with increasing binder concentration,the granules occupied larger volume making the bulk density value lower than smaller granules occupying smaller bulk volume (Aklilu, 2002).

The result also indicated that the granules of Ayoyo have Carr's index less than 15% implying that the granules have excellent flow property. The granules of gelatin have Carr's Index within the range of 15-22%.

The Hausner Ratio was also observed to be less than 1.25 for Ayoyo granules, which also confirmed that the granules have good flow property while the Hausner's ratio for gelatin granules falls within the range of 1.2-1.29 which signifies that the granules have either fair or passable flow property.

The angle of repose was also observed to be less than 30^0 as shown in table 5 which confirms that the granules prepared using both Ayoyo and gelatin have excellent flow properties except for granule prepared using gelatin 2% which has an angle of repose of 31.08^0 indicating good flow property.

Increasing binder concentration affects flow properties of granules as the cohesive and adhesive forces as well as moisture content of the granules increases as the binder concentration also increases (wells *et al*, 2007).

The moisture content (%) of the granules (table 5) was observed to increase as the percentage of binder incorporated into the granule increases. By implication, when a high concentration of binder is incorporated into granules meant for compaction into tablets, the moisture content of the granules becomes high, which may affect drugs that undergo hydrolysis.

The diameter for all the tablets of the different batches were uniform as indicated in table 6 with a highest deviation of ±0.52 from the average tablet diameter.

At a constant compression force, tablet thickness varies with changes in die fill, particle size distribution and packing of the powder mix being compressed and with tablet weight, while with a constant die fill thickness varies with variation in compressive force. Tablet thickness should be controlled within a ±5% variation of a standard value (Odeku *et al*, 2008).

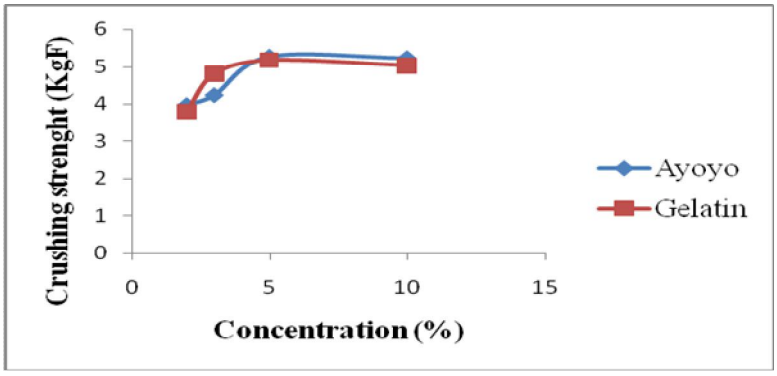

Figure 1:Effect of varying binder concentration on the crushing strength of the paracetamol tablet formulations.

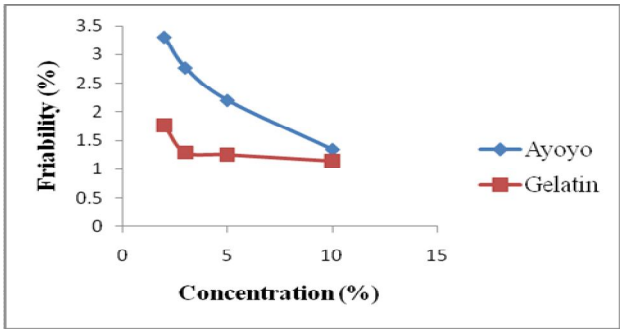

Figure 2:Effect of varying Binder Concentration on Friability of the paracetamol tablets formulations

From the results shown in table 6, the variation in the tablets thickness of all the batches ranges between ±0.00 to ±0.42. This ranges fall below the permitted ±5% variation which indicates that the tablet thickness is consistent in all batches.

The physical dimension of the tablet, along with the density of the material in the tablet formulation and their proportion, determines the weight of the tablets. From the results shown in table 6, the standard deviation of tablet weights in the different batches ranges between 0.01 and0.03. This is less than the 5.0% difference permitted for tablets with average weight of more than 324mg (USP, 2007).

The hardness of a tablet provides information on the tablets resistance to capping, abrasion or breakage under conditions of storage, transportation and handling before usage. If a tablet is too hard, it may not disintegrate in the required period of time to meet the dissolution specification; if it is too soft, it may not be able to withstand the handling during subsequent processing coating or packaging and shipping operations (Odeku *et al*, 2008).Crushing strength that falls within the ranges of 3-6KgF is considered to be normal for satisfactory tablets. Form the results in figure 1, all the tablets fall within this range of crushing strength except concentration 10 % w/v, the crushing strength increases with increasing binder concentration and this is due to the increasing binding capacity of binders at high concentration leading to a greater bonding force among granules during compression (Armstrong *et al*, 1988).

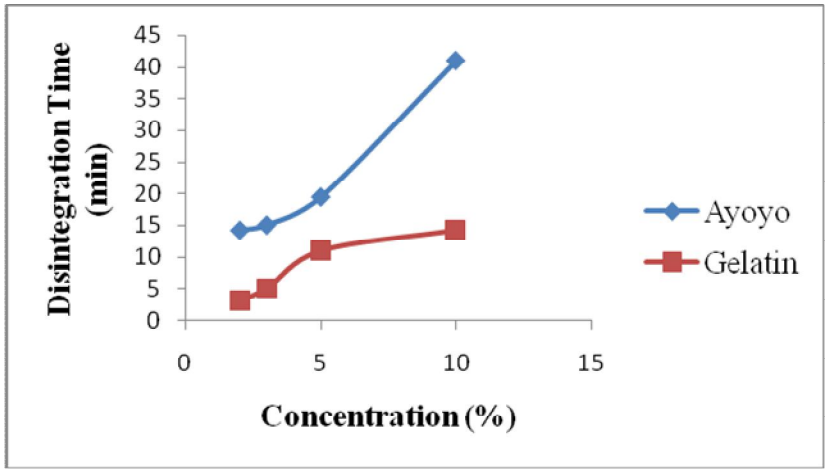

Figure 3:Effect of varying Binder Concentration on Disintegration Time of Paracetamol Tablet formulations.

Table 7: Time taken for 50% and 70% of Paracetamol to be released.

Parameter	t50% (mins)		t70% (mins)	
Concentration (%)	Ayoyo	Gelatin	Ayoyo	Gelatin
2	16	2.2	45.2	3
3	7.5	4.5	49.5	16
5	3	17	24	> 60
10	5	9	> 60	13

Key: t50 and t70= the time taken for 50% and 70% of paracetamol to be released respectively**.**

Friability test is closely related to tablet hardness and is used to evaluate the ability of the tablet to withstand abrasion in packaging, handling and shipping. A maximum weight loss of not more than 1% of the weight of the tablets being tested during friability test is considered generally acceptable (USP, 2007). All the tablets of the different batches passed the friability test as the percentage loss was over 1% except at 2% w/v concentration (figure 2).

Disintegration test is a measure of the time required under a given set of conditions for a group of tablets to disintegrate into particles.

The tablet disintegration test is used for providing simple and useful means for monitoring and controlling the quality of tablets. It also gives an insight of release pattern of formulation.

For most uncoated tablets, the BP (2002) stipulates that the tablets disintegrate within 15 min.

From the results shown in figure 3, five batches passed the disintegration test as they were able to disintegrate in 15 min. Three batches i.e. containing 3%, 5% Ayoyo and 10% Ayoyo failed the test. This may be due to the higher binder concentration, additional bonds are formed and disintegration medium cannot easily penetrate to break the tablet.

The dissolution test measures the time required for a percentage of the drug substance in a tablet to go into solution under a specified set of conditions. It describes a step toward physiological availability of the of the drug substance, but is not a measure of the safety or efficacy of the tablet being tested (Odeku *et al*, 2008). It is considered as one of the most important quality control test performed on pharmaceutical dosage form.

The factors that affect dissolution include type and concentration of binder, hardness, surface area, distance of diffusion, solubility of the drug, manufacturing process (wet granulation or direct compression) and diluents. (Ngwuluka*et al*, 2010).

The times taken for 50% and 70% of paracetamol to be released are shown on table 7. Of the four concentrations of Ayoyo used, only tablets formulated using 10% concentration requires more than 60 min to release 70% of the drug. This means that at high concentration, Ayoyo gum can be used as release retardant in tablet formulation.

CONCLUSION

This present study shows that formulation containing Ayoyo mucilage as a binder has good flow properties as well as physicochemical properties as compared to the standard (gelatin) but has slower release properties. Therefore, Ayoyo mucilage may be used as a binder in sustained release tablets.

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