Investigation of Starche (ES) From *Artocarpus Altilis* as Potential Excipient on Albendazole Tablet Formulation

Ordu J I* and Owhor, G A

Department of Pharmaceutics/Pharmaceutical Technology,
Faculty of Pharmaceutical Sciences, University of Port Harcourt, Nigeria

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Abstract- The study is, focused on, use of the isolated starch from *Artocarpos altilis* seeds obtained following aqueous and alkaline hydrolysis and evaluating for the binder and disintegrant properties on albendazole tablet formulation utilizing wet granulation technique. The resulting granules and formulated tablets were, compared with that from cornstarch using standard methods of quality control reference to official procedures. Tests involving, crushing strength was, conducted on formulated tablets from extracted *A.altilis* and cornstarch. Result obtained reveal that alkaline hydrolyzed *A.altilis* starch had crushing strength of 3.2Kg/f while the aqueous extract and corn starch had similar value of 5.0Kg/f. Disintegration result on the formulated tablets containing *A.altilis* and corn starch shows that tablet formulated from aqueous extract disintegrated at 40.7mins, the alkaline at 50.7mins and that from corn starch at 35.8mins. All of the tablets produced showed comparative dissolution profiles and the content uniformity analysis reveals a percentage range of 96.9-105.8%.

Index Terms- *A. altilis* starch, Albendazole, tablet, excipient

I. INTRODUCTION

Formulations are set of operations that, aims to produce a physical system containing a drug in order to meet the quality requirement set in advance to ensuring the maintenance of the efficacy and safety characteristics of active substances [1].
Pharmaceutical formulations often therefore associates the concern of stability in the design of dosage forms although currently in addition to facilitating drug delivery and stability, large scale reproducible production of medicines must comply with specification that ensures adequate pharmacokinetic properties and incorporating high bioavailability characteristics [2].

In practice, pharmaceutical formulations must involve in such activities as, excipients selection, production process, and evaluation of the products obtained by carrying out standard physicochemical and physicotechnical analysis to allow for the proper choice, optimization, and usage of pharmaceutical preparations based on the pre- established specifications.

To ensure adequate and targeted drug delivery therefore, pharmaceutical formulations can be made into various dosage forms such as solids example tablets, capsules, powders for reconstitution, suppositories or liquid and semi-solid dosage forms as in solutions, suspensions, emulsions, creams, pastes and so on [3].

Tablet is a typical example of solid dosage forms whose formulation procedure, involve molding or compression and consist of an active pharmaceutical ingredient and excipients. These excipients are pertinent in the successful formulation of acceptable pharmaceutical dosage forms as is being observed in the final product outcome [4].

The role of the excipients vary substantially in drug production depending on the individual dosage form hence the US Pharmacopoeia-National formulary (USP/NF), categorizes excipients according to the roles they play in the formulation process example as binders, disintegrants, colorants (dyes), flavours, fillers(diluents), lubricants, preservatives, wetting agents and so on.

The presence of fillers such as, starch, lactose, dibasic calcium phosphate dehydrate, etc, will enhance the strength of a well formulated and compressed tablet. Such will also help to withstand the rigors of mechanical shocks encountered in the process of production, packaging, shipping, and dispensing, with the advantage of being simple for medication, enhancing accurate dosing and convenience for administration as a dosage form [5].
Pharmaceutical tablets therefore are commonly processed by adopting techniques as direct compression, dry granulation and wet granulation. The method chosen is dependent on the ingredients individual characteristics like flow property, compressibility and particle size [6].

Direct compression, involves the compression of powdered materials without changing their physical nature. The compression is, generally done for the crystalline material with acceptable physical properties such as flow, compressibility, and free moisture content. The process has the advantage of time saving, safety of operation and low cost.

Dry granulation process involves the formulation of granules without addition of liquid solutions and is, often recommended for products sensitive to moisture and heat, hence requires compaction and densification of the powders by slugging with the use of a tablet press.

Wet granulation on the other hand is the most widely used method and it involves a multistage process which could be time consuming but not applicable to moisture and heat sensitive materials. Steps involved include, weighing and mixing; wet massing and screening, drying and dry screening, lubrication and addition of exo excipients, dry mixing and compression.

The process is also associated with such advantages as, improvement in cohesiveness, promotes distribution and uniform compaction of poorly soluble drugs, prevents segregation of

components, enhances dissolution rate of hydrophobic drugs and reduces air entrapment thereby increasing powder compressibility [7].

Evaluation of tablet *in vitro* involves

Non-pharmacopoeial **(**unofficial) tests not listed in the British Pharmacopoeia, have no official set limit hence could vary from various production units and such includes: crushing strength, a measure of the pressure required to crush a tablet when placed on its edge. It is a function of the physical properties of the granules such as, hardness and deformation under load using instruments as the Mosanto-Stokes Erweka, Strong-Cobb and Pfizer crushing strength testers.

No fixed value exists and measurement is often done using minimum of ten tablets and the tensile strength calculated using the relation.

$$Ts = \frac{2p}{\Pi dt} \quad \ldots\ldots\ldots\ldots\ldots\ldots 1$$

Friability test involving measurement of the resistance of tablets or granules to abrasion. The tablets are, dedusted, weighed and subjected to weel-defined level of agitation in a closed chamber at fixed geometry for a specified time, then removed, dedusted and reweighed again. The abrasion resistance (B) is calculated and values of B of 0.8% -1%, is often, adopted as the upper level of acceptance for pharmaceutical products [8].

Pharmacopoeial tests includes such as, Content uniformity which involves assay of individual tablets up to ten and the batch fails to comply if more than one tablet is outside the range of 85% to 115% of the average value or if any tablet is outside the range of 75% to 125% of the average.

Disintegration test is conducted using the disintegration apparatus with a single unit containing six tubes. For most conventional tablets, the time permitted is 15minutes and tablets are regarded to have disintegrated if no fragment (other than fragments of coating) remains on the screen but if particles remain, they should be soft without any unwetted core. Dispersible tablets are expected to disintegrate within 3minutes at 19-21^{o}C and effervescent tablets in 200ml of non-agitated cold water at 15-25^{o}C must disintegrate within five minutes.

Dissolution test especially involving *in-vitro* method is undertaken to ensure that release of drug from tablet is as close to 100% and to show that the release rate from each batch is uniform and same as that from those batches proven to be bioavailable and clinically effective. Equipment used in performing dissolution test as recommended by the British Pharmacopoeia includes such as, rotating basket, rotating paddle and flow through cell. Commonly, the result of dissolution test is expressed in terms of the time required to release some percentage of noted amount of drug from the dosage form. The dissolution rate of drugs from compressed tablets may be influenced by such parameters as, type and volume of dissolution medium, type of dissolution apparatus, temperature and agitation time [8].

Starch: Starch is a natural polysaccharide stored in plant parts and serve as an energy source more so since it is the main carbohydrate reserve in plants. It is a dry, odorless soft powder, bland in taste and in some cases, the color and odor varies characteristic of the botanical sources but their intrinsic physicochemical properties especially of the native starch remains unaltered and many are commercially available. Starch may be associated with certain components as lipids, proteins, essential minerals as calcium, potassium, and magnesium all of which might help to increase the functionality of the starch and impact certain qualities as hardness, high crystallinity requiring high energy for gelatinization although these measures are characteristics of each species [9].

Starch functionality is directly, related to gelatinization and properties of paste formed immediately after the gelatinization. These attributes affect the stability of products formed, consumer acceptance and production reliability. The characteristics of the native starch, the effects of the physical or chemical modifications of the granules, the process parameters and the botanical source of the starch are all critical factors governing the behavior and characteristics of pastes formed with the starch [10].

Some functional properties of starch includes, swelling, hydration capacity and solubility of starch granules and one of the most important structural characteristics of starch is that it passes through several stages from water absorption to granule disintegration. Considering *in-vitro* tablet evaluation, the swelling capacity and solubility of starch illustrates the activity of the polymeric chains contained in the amorphous and crystalline granule fractions. The extent of the interaction is influenced by the amylose-amylopectin proportion characteristic of each molecule which also depends on the polymerization degree, length, and grade of chain branching, molecular weight and conformation [11].

Natural starch and Pharmaceutical uses

Starch from natural sources such as seeds of *Artocarpus altilis* plant are being, sourced as pharmaceutical excipients, as such excipients could be recognized and utilized as components of conventional and novel drug product providing specific functions and aiding in the formulation of low cost, optimally elegant, stable and safe/acceptable pharmaceutical products [12].

Naturally occurring starches has also been evaluated as drug carriers in controlled drug delivery, serving multifunctional purposes in different physical forms as binders, disintegants, diluent, glidants and lubricants especially in pharmaceutical solid dosage formulation.

Despite the functional versatility of natural starch, certain properties make it less efficient and dependable as an excipient in conventional and innovative formulations. The intrinsic moisture content and absorption properties are among the important factors that will provide information and basis for selecting excipients for a particular formulation as the moisture content will affect such parameters as powder flow, compaction, and tensile strength of granules and subsequent tablets stability.

Natural starches could undergo plastic deformation when compressed under pressure to form load compact and high elastic recovery which could result to soft compact, the tendency to undergo pure elastic deformation could be dependent on such factors as moisture content, particle size and shape distribution. These often are responsible for the variation in compaction characteristic of starches from different botanical sources [13].

Albendazole: This is a broad spectrum oral antihelminthic, a drug of choice for treatment of hydratid disease and cysticercosis. It is used in the treatment of pinworm and hookworms infections, ascaris, tricuriasis and strongloidiasis [14].

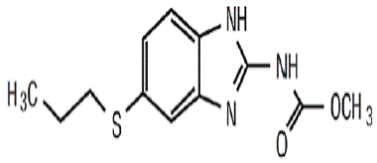

Fig I: Chemical structure albendazole

Chemically it is Methyl 5-propylthiol- benzimidazole carbonate, with molecular formulae $C_{12}H_{15}O_2S$ and mol. weight 265.

Albendazole is a white to yellow powder, soluble in anhydrous formic acid, acidified methanol and very slightly soluble in ether and methylene chloride but practically insoluble in alcohol and water. It is poorly absorbed from gastro intestinal tracts due to its low aqueous solubility, highly plasma protein bound (70%) and widely distributed in the body and detected in urine , bile, liver and cerebrospinal fluids(CSF). It is rapidly metabolized in the liver to the primary metabolite, albendazole sulphoxide, which is further metabolized to albendazole sulfone and other primary oxidative metabolites identified in human urine. Albendazole binds to nematode β- tubulin, inhibiting polymerization thus preventing the formation of microtubules and so stopping cell division and impaired uptake of glucose leading to depletion of glucagon and reducing stores of adenosine tri phosphate (ATP) [15].

Short-term intake of albendazole leads to mild and transient epigastric distress, headache, nausea, insomnia while long-term administration can cause abdominal distress, fever, increase in liver enzymes and pancytopenia. Safety of albendazole in pregnancy and children younger than 2years of age has not, been established.

This study is aimed at the physicochemical characterization of starch(es) from *Artocarpus altilis* seeds in comparison to corn starch and assessment of the properties of the starch(es) as possible excipients (binders and disintegrant) in albendazole tablet formulation.

II. MATERIALS AND METHODS

Methanol, concentrated HCl, iodine solution, perchloric acid, 0.1N HCl, magnesium stearate, talc, friabilator, dissolution apparatus(Erweka England), disintegration apparatus(Erweka), UV spectrophotometer, sensitive weighing balance, tabletting machine (Siemens Germany), pH meter, atomic absorption spectrophotometer (Hitachi model 170-10), micrometer screw gauge, Oven (Memmert), Markam Still Distillation Apparatus, crucibles.

III. METHOD

Microscopic analysis: a little quantity of the starch powder was mounted in a visible-light microscope and viewed at x 40 lens. Determination of pH: the ph values of 1%w/v starch suspensions were determined using digital ph meter.

Hydration capacity: A 1g of *Artocarpus altilis* seed starch (Wo) was placed inside an already weighed centrifuge tube and the weight (W_1) noted then covered with 10ml of distilled water. The tube was shaken for 5mins, allowed to stand for 15mins before centrifuging at 3000rpm for 10mins. The supernatant was decanted and the weight of the powder after water uptake and centrifugation was determined (W_2).

Water-binding (hydration) capacity (H) was, calculated as:

$H = W2 - W1/W1 - W0 * 100$ --------- (1)

Where: W2-W1= Weight of bound water, W1-W0 = Weight of sample

Swelling index: The swelling capacity was determined by filling a 100ml graduated cylinder to the 10ml mark with the starch powder. Distilled water was added to reach a total volume of 100ml, the top of the graduated cylinder was covered and mixed then allowed to stand for 12hours after which the volume occupied by the sample was taken.

CHARACTERIZATION OF STARCH(ES)

Bulk and Tapped densities

A 20g quantity (Wp) of starch powder was gently introduced through a short stemmed glass funnel into a 250ml graduated cylinder. The volume occupied by the powder was taken as V_b. The powder was tapped on a padded table top from a height of about 7mm until no further change in volume was observed. The volume (V_t) was taken as the tapped volume. The bulk and tapped density were computed using the formula

$Bd = \frac{W_p}{V_b}$ …… (2) $Td = W_p / V_t$ …… (3)

Where Bd is bulk density; Td is tapped density; W_p is weight of powder; V_p is volume of powder and V_t is the tapped volume.

HAUSNERS RATIO (H_R) AND CARR'S COMPRESSIBLITY INDEX (CI)

Hausner's ratio and the Carr's Compressibility Index are calculated using the formula:

$H_R = \frac{Td}{Bd}$ ---------- (4)

$CI = \frac{Td - Bd}{Td}$ ---------- (5)

ANGLE OF REPOSE: The static angle of repose (θ) was measured according to the fixed funnel and free standing cone method and the tangent of the angle of repose calculated using the equation $Tan\theta = 2h/D$ …… (6) h is the height of the powder and D = diameter of the base powder heap.

FLOW RATE: Using the flow through the hopper method, 30g of the granules from each batch was, measured allowed to pass through the orifice, and the time taken to pass through was recorded. The flow rate was determined using the relation;

Quantity of granules (g) per unit time (s) = $\frac{m(g)}{t(s)}$ --------- (7)

TABLE 1: TABLET FORMULATION

***Atocarpus altilis* SEED STARCH**		**CORNSTARCH**	
Albendazole	200mg	Albendazole	200mg
Gelatin	1.0%w/w	Gelatin	1.0%w/w
Breadfruit seed starch	8.0%w/w	Corn starch	8.0%w/w
Magnesium Stearate	1.0%w/w	Magnesium Stearate	1.0%w/w
Artocarpos altilis seed starch	10.0%w/w	Corn starch	10.0%w/w
Talc	2.0%w/w	Talc	2.0%w/w

TECHNIQUE OF FORMULATION: Wet granulation method, was adopted and involved use of intra and extra-granular components of the starch granule for tablet formulation.

The starch as an intra-granular component was, weighed and triturated with API (albendazole) to reduce their size. Gelatin already weighed was dispersed in 2ml of water and allowed for 15minutes after which it was warmed gently to enhance its dissolution while stirring gently and avoiding air bubbles. The gelatin solution was, incorporated into the powder mixture in aliquots, wet massed and mixed; a little quantity of water at the same temperature was added to form the wet mass and this was passed through a 2mm sieve aperture.

The screened damp mass, was spread in thin layer on a tray to dry in an oven at 45ºC until the granules were completely dried. The dried granule was, screened through a 1mm sieve then stored at 45ºC until appropriately dried.

The extra-granular excipients, was weighed, incorporated in aliquots, and mixed with the dried granules adopting, doubling-up technique. After this the powder mix was, compressed to tablet using a single-punch tabletting machine maintained at a pressure of 5KgF to obtain a targeted weight of 244mg

QUALITY CONTROL OF TABLETS

The compressed tablet was, assessed for their characteristic color, odor and thickness, which involve the measurement of 5 tablets using micrometer screw gauge and controlled using a ± 5% variation and expressed in mm.

Crushing strength test: Mosanto hardness tester was used, to evaluate the crushing force of the tablet. The tester consists of a barrel containing a compressible spring held between two plungers. The lower plunger is, often placed in contact with the tablet while the upper plunger is then forced against a spring by turning a threaded bolt until the tablet breaks to pieces. As the spring is compressed, a pointer rides along a gauge in the barrel to indicate the force. The force of fracture is recorded in KgF.

FRIABILITY TEST: This was determined using a Roche friabilator where 10 tablets were, dedusted, weighed and placed in the friabilator, operated at 25rpm for 4minutes. The tablets were removed, dedusted and reweighed. The difference in weight is used, to calculate the friability and value expressed in percentage.

$$\%\text{Friability} = \frac{\text{Weight of tablets before testing}}{\text{Weight of tablets after the testing}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

WEIGHT UNIFORMITY TEST: This was determined by weighing 20 tablets individually, calculating the average weight, and comparing the individual tablet weight to the average. The weight variation is expressed in percentage as,

$$\text{Weight variation} = \frac{(I_w - A_w)}{A_w} * 100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (9)$$

Where I_w= individual weight of tablet; A_w = Average weight of tablet.

BEER-LAMBERTS PLOT FOR ALBENDAZOLE

50mg of pure albendazole powder was placed in a 100ml volumetric flask and dissolved in 50ml of acidified methanol. The stock solution was used to make different concentrations of albendazole; 0.2ml was obtained and made up to 10ml with 0.1NaOH to make a solution of 0.02mg/ml, the same was repeated to obtain 0.04, 0.06, 0.08, 0.1 and 0.12ml of the stock solution. Each of the concentration was, filtered and 0.1ml of it subjected to UV spectrophotometer at λmax 308nm.The absorbance obtained was plotted against the various concentrations to obtain the Beer's plot.

CONTENT UNIFORMITY TEST

20 tablets were selected, crushed and the average weight of the tablets taken then dissolved in 50ml acidified methanol and made up to 100ml using 0.1N NaOH. The solution was filtered and 0.1ml of filtrate was diluted to 10ml and the absorbance determined using a UV spectrophotometer at λmax 308nm. The result obtained was used to calculate for the percentage active ingredient. Limit value for albendazole is between 90-110%.

DISINTEGRATION TEST

The USP disintegration apparatus consisting of 6 glass tubes was used. One tablet was placed in each tube and the basket rack was positioned in a 700ml solution of acidified methanol in 0.1N NaOH at 37 ± 2ºC such that the tablet remain 2.5cm below the surface of the liquid on its upward movement and not descend closer than 2.5cm from the bottom of the beaker. A standard motor driven device was, used to move the basket assembly containing the tablets up and down through distance of 5 to 6cm at a frequency of 30cycles per minute. Perforated plastic discs, was used in the test; they were placed on top of the tablets to impart an abrasive action to it. The test was run for 1hour and results recorded accordingly.

DISSOLUTION TEST

The Erweka dissolution apparatus was, used as it consists of cylindrical basket. The vessel was immersed partially in water bath at a temperature of 37 ±0.5ºC during the test, keeping the bath fluid in constant smooth motion. A 900ml volume of a solution of acidified methanol in 0.1N NaOH mixed in a ratio of 1:100 was, used as the dissolution medium. The medium was equilibrated to 37±0.5ºC and each tablet was placed in the apparatus, taking care to exclude air bubbles from the surface of the tablet. The apparatus was, operated at 75rpm for 1hour. After an interval of 5mins, 10ml aliquots of the medium was withdrawn, filtered and replaced appropriately. The UV spectrophotometer was, used to determine the absorbance of the filtrate λmax 308nm, and the results obtained recorded accordingly and used to calculate the percentage drug release then compared with reference from official standard.

IV. RESULTS

TABLE 5: FUNCTIONAL PROPERTIES OF Artocarpus altilis seed STARCH WITH STANDARD CORN STARCH

PROPERTY	Sw/e	Sa/e	Sc
MELTING POINT	240-243ºC	238-240ºC	256-258ºC
pH	7.1	7.2	7.0
SWELLING INDEX	10.17	8.026	14.36
WATER-BINDING CAPACITY	104.5	81.5	121.5

KEYS: Sw/e= water extracted starch; Sa/e= alkaline extracted starch; Sc= corn starch

SAMPLE	BULK DENSITY(g/ml)	TAPPED DENSITY (g/ml)	HAUSNERS' RATIO	CARR'S INDEX	ANGLE OF REPOSE (θ)
Sc	0.41 ± 0.02	0.55 ± 0.0043	1.32 ± 0.0502	24.05 ± 2.95	32.3 ± 0.36
Sw/e	0.44 ± 0.0147	0.63± 0.0196	1.42 ± 0.0093	29.41 ± 0.4666	35.57 ± 1.8230
Sa/e	0.44 ± 0.0099	0.60± 0.0027	1.34 ± 0.0910	25.13 ± 5.0156	35.67 ± 0.9292

TABLE 6: PHYSICOTECHNICAL PROPERTIES OF THE STARCH

TABLE 7: PHYSICO-TECHNICAL PROPERTIES OF ALBENDAZOLE GRANULE .

SAMPLE	BULK DENSITY	TAPPED DENSITY	HAUSNERS RATIO	CARR'S INDEX	FLOW RATE	ANGLE OF REPOSE (θ)
Cs	0.53 ± 0.008	0.61 ± 0.000	1.14± 0.002	12.32±1.355	3.85±1.005	30.74±4.056
Sw/e	0.48 ±0.007	0.51 ± 0.007	1.06 ± 0.015	5.59±1.342	4.77±0.318	31.66±2.132
Sa/e	0.52 ± 0.0151	0.55 ± 0.009	1.06 ± 0.014	6.01±1.291	5.13±1.727	32.28±3.096

TABLE 8: PROPERTIES OF FORMULATED ALBENDAZOLE TABLETS

Tablet formulation (Batch)	Crushing strength (KgF)	Friability (%)	Disintegration time (mins)	Drug content (%)
Cs	5.0250	0.2014	35.80	98.9
Sw/e	5.0200	0.1580	40.70	105.1
Sa/e	3.2000	0.1467	50.70	105.8

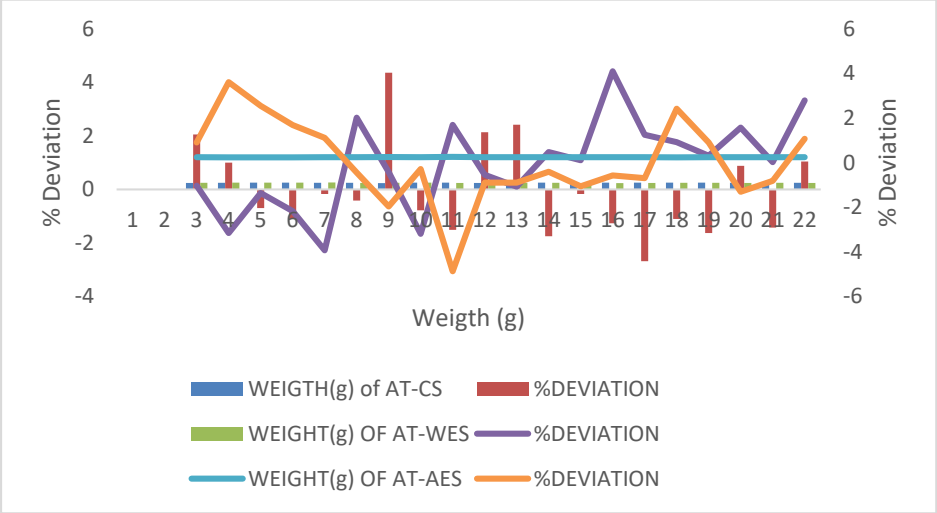

Fig 3: WEIGHT UNIFORMITY (%) DEVIATION OFALBENDAZOLE TABLET

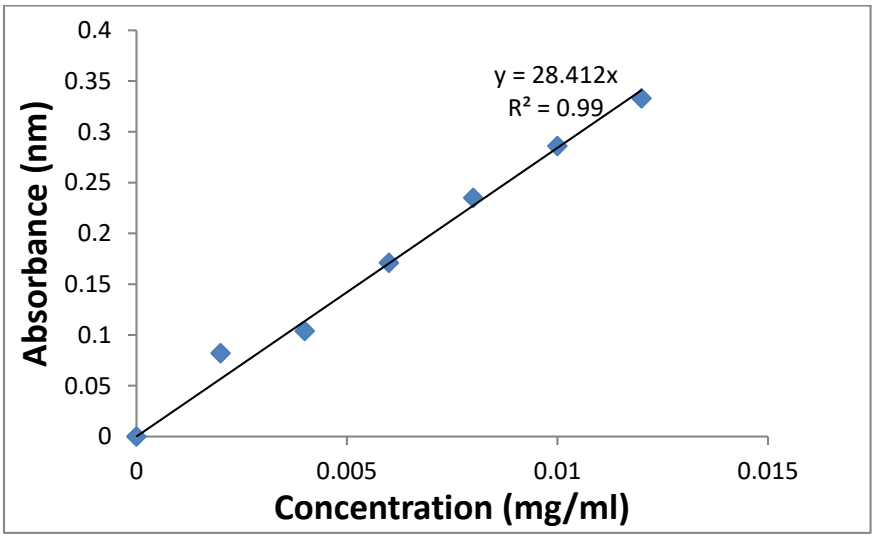

FIG 4: BEER-LAMBERTS ASSAY OF ALBENDAZOLE POWDER

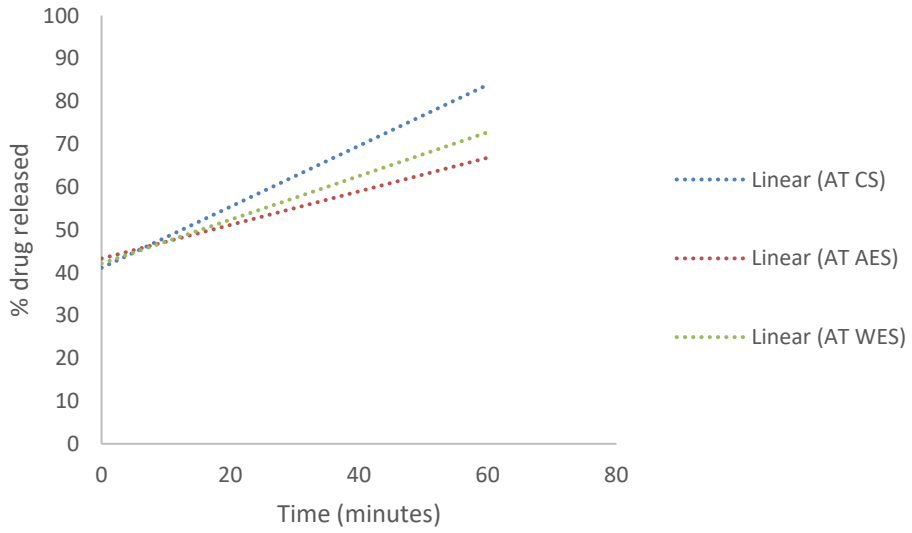

Fig 5: Plot of percentage drug release against Time (minutes)

KEYS:
AT-WES = albendazole tablets formulated with water extract starch
AT-AES = albendazole tablets formulated with alkaline extract starch
AT-CS = albendazole tablets formulated with corn starch

STATISTICAL ANALYSIS

T-Test Summary on Significant Difference of Friability and Crushing strength for 6 Batches of formulated tablets.

Characteristic	t	df	Sig.(2-tailed)	Mean Difference	95% confidence interval of the difference	
					Lower	Upper
Friability	6.082	5	0.002	21.950	12.673	31.227
Crushing Strength	**4.937**	**5**	**0.004**	**3.387**	**1.624**	**5.150**

V. DISCUSSION

The extracted *A.altilis* starch(es) were analyzed and compared with a standard (corn starch). The melting point values obtained as in table 6, showed similarities across the extracted starches and the standard corn starch indicating purity and absence of extraneous materials. The pH of the extracted starch was found to be in the range of 7.1 to 7.2 for the water-extract and the alkaline-extracted starch respectively, similar to corn starch (pH 7.0) showing the starches as a rather neutral substance that does not require preliminary acidification or basification hence useful for the human physiological system. The swelling index as well as the hydration capacity of the extracted starches was less than that of the cornstarch. This depicts the extracted starch as being indiffusible hence might not possess suitable water retention and absorption capacity characteristic of a binding agent but may be suitable as an excipient for suspension formulation aided by a suspending agent or as a direct compression tablet excipient which may be useful as a disintegrant.

Physico-technical characterization of the extracted starch indicates poor powder flow characteristic referenced to official standards. In order to improve the flow properties of the starch wet granulation technique was, adopted for the granule formation. The physico technical properties of the granules showed an improvement in the flow properties of the starch as the Carr's index of the water-extracted starch gave a value of 4.76 and that of the alkaline-extracted starch 5.12 and according to the USP Carr's Index values ≤10 indicates excellent flow characteristics. After granulation the values for the Hausner's ratio for the water-extracted starch was1.059 and that of the alkaline-extracted starch 1.064 and according to the USP, values between 1.00-1.11indicates an excellent flow property of the granules

Friability is a disruptive force used to evaluate the ability of tablets to withstand chipping and breakage during use. The friability test showed variation of values amongst the albendazole tablets formulated; from table 8 it was observed that the corn starch formulated albendazole tablet was more friable than the albendazole tablets formulated with breadfruit seed starch especially the aqueous extract while the alkaline-extracted starch had the least value among the tablets formulated. This is supported using statistical evaluation where, following t-test conducted, friability had a t-value of 6.082 and mean difference of 21.95 which falls within the interval (12.67 and 31.23). A p-value of 0.002 was also derived which means that there were significant differences with ($p < 0.05$) in the friability values of the three batches. Therefore the modification exerted on the extracted *A. altilis* starch by the alkaline medium would have assisted in decreasing inter molecular bonding but caused an increase in porosity, hence may easily be prone to forces of abrasion and chipping and therefore might not be very suitable as a binder in tablet formulation.

The crushing strength measures the ability of the tablet to withstand mechanical shock in handling, manufacture, packaging and shipping. The results for the crushing strength test showed that the tablets formulated with the water-extracted starch possess crushing strength similar to that of corn starch tablets (5.02KgF to 5.025KgF) respectively, while that for the alkaline-extract had value of 3.20KgF depicting the extraction method as producing particles that are amorphous and not crystalline as in the aqueous extracted type. The alkaline extracted starch seems to be associated with increased porosity than the aqueous extracted so might not possess strong force for inter particulate bonding. This characteristic nature might make the alkaline extract most useful as a disintegrant rather than a binding agent in tablet formulation using wet granulation method.

From statistical analysis using t-test, crushing strength of the tablets formed had a t-value of 4.937 and mean difference of 3.387 and similarity between the aqueous extract and cornstarch was shown but with significant difference to that of the alkaline extracted starch.

Weight uniformity of the three batches of tablet formulated was determined and the results provided in fig 3 shows that none of the formulated tablet deviated outside the range recommended in the British Pharmacopoeia (BP). According to the BP, tablets whose weights are >80mg but <250mg should not deviate by more than ±7.5. Therefore, the weights of the formulated tablets showed uniformity across all batches.

The disintegration test result shows that the water-extracted starch disintegrated within 41minutes, the alkaline-extracted starch within 51minutes while that with cornstarch was 23minutes. None of the formulated tablets disintegrated within the time stipulated by the BP for conventional tablet, which should be within 15minutes. Therefore, the tablets formed using the *A.altilis* starch, may be, due to considerably higher amorphous nature of both the starch and the API (albendazole powder) relative to corn starch could not absorb water and break down promptly hence may find useful application as a direct compression excipient or as ingredient in suspension drug formulations. The cornstarch seems to be more crystalline and the tablet formulated with it, showed faster disintegration hence has appreciable binding and disintegrant property as it could absorb water, swell faster and burst to release the tablet content although action was slow due to influence of the amorphous nature of the API.

The results for the content of active ingredient as in table 8, shows that the content of albendazole in all formulations fall within the range of the acceptable standard (90-110%) reference to British Pharmacopoeia 2004. Formulation with cornstarch was 98.9%; water-extracted starch 105.1%, and that of the alkaline-extracted starch 105.8%. This depicts that active ingredient and the excipients used in the formulation were compatible without chemical interaction.

Comparison of dissolution profile of the three batches of Albendazole formulations, it shows that the tablets formulated with cornstarch possess the highest percentage of drug release about 90%, followed by the alkaline-extracted starch 74.1% while the water-extracted starch was 71.4%. The outcome of this result could be due to the effect of gelatin incorporated in the formulation, which may exert choice synergetic binding effect with the *A.altilis* starches than the cornstarch.

VI. CONCLUSION

From the study, starches from *Artocarpos altilis* seed seems useful in pharmaceutical tablet formulation though the seed starch may require properly selected API and some modification for it to be accepted, as excipient in such Pharmaceutical solid dosage formulation more so, as in this study the disintegration of the resultant albendazole tablets was unpredictable. Therefore, further work is, recommended to evaluate or modify the *A.altilis* starches for applications in food and pharmaceutical formulations.

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AUTHORS

First Author – Ordu J I, Department of Pharmaceutics / Pharmaceutical Technology, Faculty of Pharmaceutical Sciences, University of Port Harcourt, Nigeria, Email address: ordujohnik@yahoo.com, Phone: ±2348037211706
Second Author – Owhor, G A, Department of Pharmaceutics / Pharmaceutical Technology, Faculty of Pharmaceutical Sciences, University of Port Harcourt, Nigeria