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Full Length Research Paper

The role of ginger starch as a binder in acetaminophen tablets

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The rhizomes of ginger, *Zingiber officinale* (Roscoe; Zingiberacea) has been reported to contain up to 56.0% starch. The starch was extracted from the fresh rhizomes, evaluated for relevant properties and used as a binder to acetaminophen tablets at concentrations of 2.0 - 8.0% w/w. The tablets were evaluated for hardness, friability, weight uniformity, disintegration and dissolution profiles. Acetaminophen tablets containing gelatin as standard binder were produced and assessed comparatively. Results obtained indicate that ginger starch performed as good as gelatin as a binder to acetaminophen tablets.

Key words: Ginger, *Zingiber officinale,* binder, zingiberacea, acetaminophen.

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 (King, 1975). Binders have been used as solutions and in dry form depending on the other ingredients in the formulations and the method of preparation. The choice of a particular binding agent depends on the binding force required to form granules and its compatibility with the other ingredients particularly the active drug (Gordon et al., 1990). Starches from different sources have been evaluated and used as excellent binders in either mucilage or the dry powdered form (Nasipuri, 1979; Tsige and Alexander, 1993; Iwuagwu, 1991). Maize and potato starches have been in common use and recently cassava starch appeared in the British Pharmacopoeia as an official starch for use as binder (British Pharmacopoeia, 2001). Their use has increased in the tropics where previously recognized starches are unavailable. Apart from starches, other natural gums, gelatin, sugar solutions, modified natural and synthetic polymers have been employed with considerable success as binders. In all evaluations, the type and binder concentrations have direct effect on the crushing strength, friability, disintegration time and tablet dissolution.

Zingiber officinale; ginger is a reed-like plant grown in many parts of the world especially in tropical countries of Jamaica, India and Africa (Trease and Evan, 1972). Ginger contains about 56.0% starch, which means that it is a good source of starch (Wallis, 1967). Proximate analysis of various dry ginger powders has been reported to contain about 61.93 - 67.21% of carbohydrate materials (Meadows, 1988). The bulk of research on ginger has been on the medicinal properties and indeed, it possesses many pharmacological properties and applications. There are ongoing researches on the physiological effects of ginger. It is currently been evaluated for use as an antibacterial, antifungal, and antidiabetic. The preliminary study on the potentials of ginger starch as binder/disintegrant in sodium salicylate tablets have been reported (Slok et al., 1992). Researches with this starch in tablets of other active ingredients are necessary because of the high percentage of starch content reported in this plant (Wallis, 1967; Meadows, 1988). The death of primary pharmaceutical industries in some developing economies has led to lack of

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basic tableting excipients despite the avalanche of unprocessed raw materials. There is the need to bridge this gap. With increasing demand and search for natural starches with desirable properties for use in the pharmaceutical industries, the present work evaluates the possible use of ginger starch as binder to paracetamol tablet.

EXPERIMENTAL

Materials

Ginger starch (prepared in our Laboratory), Paracetamol, Lactose, Maize starch, Gelatin (BDH chemicals Ltd., England), Magnesium stearate (Merck), Hydrochloric acid 37% (May and Baker).

Extraction of ginger starch

Rhizomes of ginger purchased from a local market in Nsukka were washed with water, peeled, weighed, reduced to smaller pieces and properly ground using an electric grinder. Enough quantity of water was added to soak the material for 5 h and sieved with a clean muslin cloth. The ground mass was thoroughly washed with water onto the muslin cloth into a collecting vessel to release the starch granules embedded in the parenchyma cells. The content of the collecting vessel was then allowed to settle for 2 h and the yellowish supernatant was decanted. The whitish starch mixture was stirred with addition of water and allowed to stay for 2 h and the supernatant decanted. Series of redispersions and decanting were done to remove impurities. The settled starch was scrapped off and placed into white paper to dry in open air. The starch as then milled and weighed.

Solubility determination

A 2% w/w dispersion of starch was prepared in a 50 ml volumetric flask. The dispersion was shaken frequently for some time and allowed to stand for about 8 h. It was then filtered with a filter paper and 30 ml of the clear filtrate evaporated to dryness in a pre-weighed dry crucible. The weight of starch residue obtained was determined by difference. Solubility was calculated in g/dm^3 and mg %. The same procedure was repeated for gelatin powder.

Bulk and tapped densities

Exactly 50 g of starch was weighed on chemical balance and transferred into a 100 ml measuring cylinder. The cylinder was dropped on a wooden platform from a height of 2.5 cm three times at 2 seconds intervals. The volume occupied by the starch recorded as the bulk volume. The cylinder was then tapped on the wooden platform until the volume occupied by the starch remained constant. This was repeated three times for the gelatin powder and average bulk and tapped volumes recorded. The data generated were used in computing the compressibility index and Hausner's quotient for the two starches.

Formulation of paracetamol tablets

Two batches of the tablet containing 400 mg paracetamol were prepared. The batches contained ginger starch and gelatin as binder respectively in concentrations of 2, 4, 6, and 8% w/w. Maize starch at 5% w/w acted as the disintegrant with 1% magnesium stearate as lubricant. Wet granulation method was employed in the formulation of the tablet batches.

Granulation and compression

Wet granulation method was used for all tablet production. Calculation was made for 50 tablets in each batch. In each case, accurately weighed quantities of paracetamol, lactose and disintegrant were mixed in a mortar and the binder solution (gelatin) or mucilage (ginger starch) added to obtain a damp coherent mass. The damp mass was sieved with 1.7 mm sieve and dried at 50ºC in oven for 1 h. The dried granular mass was passed through a 1.0 mm sieve to obtain uniform sized granules. The different batches of the granules were then mixed with calculated equal quantities of magnesium stearate using mixing bottle, and then compressed into tablets under constant pressure with a Manesty single punch (Type F_3, England) tabletting machine. The punch size and volume of fill were carefully adjusted to give the required tablet size and weight.

Evaluation of compressed tablets

Hardness test

Five tablets were selected at random from each batch to perform this test. Monsanto harness tester (Manesty machines Liverpool, England) was used to measure the hardness. Tablet was placed between spindle and anvil of the tester and the calibrated length adjusted to zero. The knob was then screwed to apply a diametric compression force on the tablet and the position on the calibrated length at which the tablet broke was recorded in kgf units. A mean hardness was calculated for each batch and thus their standard deviations and coefficient of variations and coefficient of variation were calculated.

Weight uniformity test

Twenty tablets from each batch were selected randomly and weighed individually using a highly sensitive electronic balance (Saulter, Karl Kolb, Germany). Their mean weights were calculated; deviations and coefficients of variation for each batch were calculated.

Friability test

Erweka friabulator was used to carryout this test. Ten tablets were selected at random, dusted and weighed together using the electronic balance (Saulter Karl Kolb, Germany) and then placed in the Erweka friabualtor (Erweka, Germany). The machine was operated for 4 min at 120 rev/min/ and then stopped. The tablets were dusted again and reweighed. The percentage losses were calculated for each batch of the tablets.

Disintegration time

The method specified in the USP/NF (1980) was used. The machine used was Erweka multiple disintegration unit (Erweka apparatus, Type ZT4 GMBH). Disintegration medium used was 100 ml of 0.1 N HCl maintained at temperature between 35 and 39ºC throughout the experiment. Five tablets selected at random from each batch were placed one in each of the cylindrical tubes of the basket but no disc was used. The time taken for each tablet to break up into small particles and pass out through the mesh was recorded. Mean disintegration time was calculated for each batch.

Table 1. Properties of ginger and gelatin powders

Properties	Ginger starch	Gelatin powder
Cold Water Solubility (g/dm^3)	16.00	13.67
Bulk Density (g/ml)	0.5560	0.5102
Tapped Density (g/ml)	0.8403	0.8696
Hausner's Quotient	1.5120	1.7034
Carr's Compressibility index	33.88 %	41.33 %

Table 2. *In-vitro* tablet properties with ginger and gelatin as binders.

Properties	Ginger starch				Gelatin powder			
Binder Concentration (%)	2.0	4.0	6.0	8.0	2.0	4.0	6.0	8.0
Mean Table Hardness (kgf)	4.4	6.0	6.5	6.5	4.3	4.5	5.6	5.7
Friability (%)	1.59	1.56	1.43	0.46	1.33	3.90	0.43	0.22
Weight uniformity* (mg)	531.5	541.19	522.07	569.09	501.52	471.43	496.49	534.16
	(13.39)	(13.01)	(14.16)	(12.70)	(10.97)	(12.00)	(15.69)	(13.71)
Mean Disintegration Time (min)	28.5	35.36	46.30	59.20	26.50	32.50	40.20	52.50
t_{50} (%)	39.50	41.90	44.40	47.00	30.00	34.60	44.90	46.30
t_{70} (%)	46.00	49.00	54.00	59.30	37.50	45.50	66.00	72.70

*Values shown in bracket represent standard deviation.

Calibration curve for paracetamol

A stock solution of 100 mg% of paracetamol was prepared by dissolving 100 mg of the drug in 100 ml of 0.1 N HCL. Various dilutions of the stock were made so as to obtain 0.01, 0.02, 0.04, 0.06, 0.08, 0.10 and 0.12 mg% with 0.1 N HCl. The absorbances of the various dilutions were then taken at mass of 245 nm using a UV-VIS spectrophotometer. A plot of absorbance, A against concentration (mg%) of the drug was made from which the calibration curve K was determined from the slope of the graph.

RESULT AND DISCUSSION

Table 1 shows the various properties of the ginger starch powder in comparison to the official gelatin powder. The ginger starch exhibited a comparatively higher solubility than ginger powder in cold waste with values of 16.0 and 13.67 gldm^3 respectively. The cold water solubility of starches is related to their amylose/amylopectin constituents. The higher the water soluble amylopectin constituent, the higher the cold water solubility of the candidate starch while the higher the cold water insoluble amylase, the reverse becomes the case. The solubility result shows that both excipients are comparable. Interestingly there is positive correlation between starch solubility and their binding/disintegrating efficiency in tablets. The low bulk and tapped densities of both gelatin and ginger starch indicate that both materials are not highly porous and are poor flowing powders. The low bulk density results when the void spaces created by larger powder particles are not filled by smaller particles in distribution leading to consolidation of powder particles (Ingram and Lowenthal, 1972). The confirmation of the non-free flaming nature of gelatin and ginger starch were gotten from the fact that their Hausner's quotient of 1.7034 and 1.512 respectively are greater than 1.2 which indicate low inter particulate friction in powder (Staniforth, 1988). However, ginger starch possessed better flow properties than gelatin with Carr's compressibility index of 33.88 and 41.33% respectively. This index as a one-point measurement does not always show the ease of consolidation of powder granules (Wells and Aulton, 1985). The in vitro tablet properties are shown in Table 2. The hardness of the tablet batches was within acceptable range of 4 - 7 kgf. It is observed that the hardness increased with increasing binder concentration. This is in agreement with previous studies on starches used as binders in comparison to other binders (Tsige and Alexander, 1993). The tablet hardness were generally higher with the ginger starch than gelatin at all concentrations of application, an indication that lower concentration of ginger than gelatin could be used to achieve the same level of binding. The same trend was observed with the friability recorded for the two binders. Gelatin and ginger starches recorded below 1.0% friability at concentration levels of 6.0 and 8.0% in the formulation. It should be noted that paracetamol tablets are generally prone to capping when starch binder concentration is less than 7.0% (Tsige and Alexander, 1993). As expected, variations in weight uniformity were less with tablets prepared using ginger starch as binder. Thus, ginger starch produced better flowing granules. The uniformity of weight also indicates

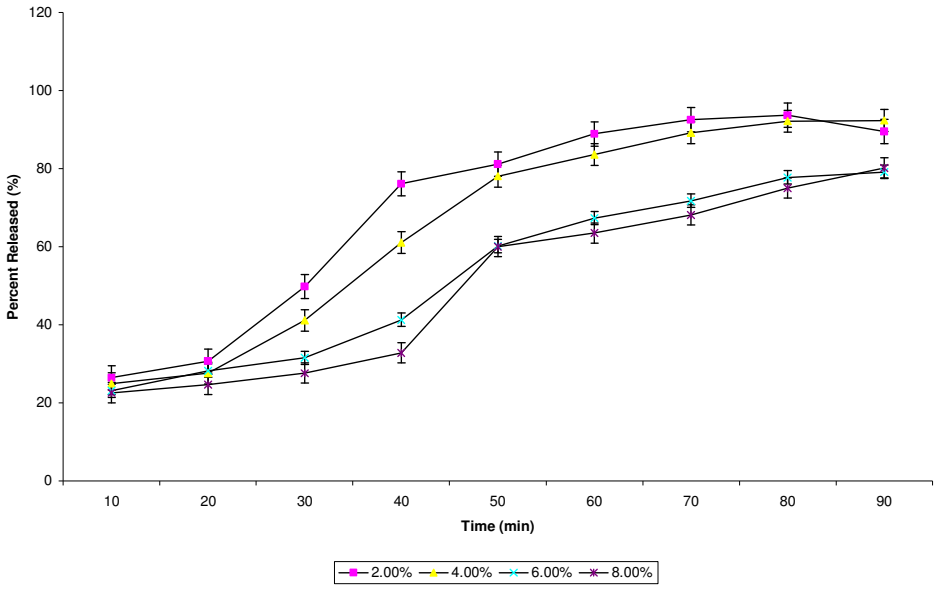

Figure 1. Graph of percentage release Vs time of tablet formulated with gelatin as binder.

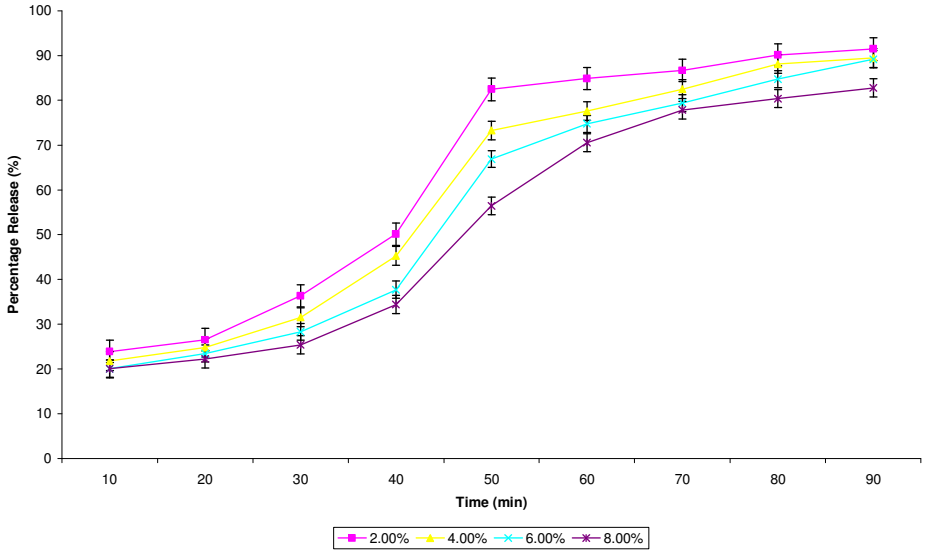

Figure 2. Graph of percent released Vs time for tablets formulated with ginger starch as binder.

probable uniformity of content. The die filling of the powder will be uniform. Similarly, the disintegration time increases with increasing concentration of binder. (It has been reported that starch mucilage used as binder forms a thin film around the granules with thickness increasing as the quantity of mucilage increases and this retards disintergration (sige and Alexander, 1993). The higher disintegration time for tablets prepared with ginger starch is therefore understandable. (The comparative dissolution profiles of the paracetamol tablets prepared with ginger starch and gelatin as binder is shown in Figures 1 and 2 respectively). In general, the amount of drug released decreased as the binder concentration increased. In all binder concentrations, gelatin showed a faster or set of release, which progressed more slowly than the ginger of equal concentration. The t_{50} and t_{70} of all the batches are similar, an indication that which starches are comparable. It could be said that the gelatin and ginger starch showed comparative effectiveness as binders to paracetamol tablets. In conclusion, ginger starch could compete favourably with gelatin

powder as binders in tablet formulations.

REFERENCES

Slok (1992) World Pharm. J. (1):23-25.
British Pharmacopoeia (2001). Majesty's Stationary Office, London, p.1576.
Gordon ER, Rosanke TW, Fonner OE, Anderson NR, Baker GS (1990). In: Pharmaceutical Dosage Forms: "Tablets, Lieberman, H.A. Lachman, L., and Schwartz (Eds.), Marcel Dekker, New York. 2: 83.
Ingram L (1972). J. Pharm. Sci. (61): 457.
Iwuagwu MA (1991). *Evaluation* of Some Soluble Starches a Lubricants in the Formulation of Compressed Tablet, World Pharm. J. 8 (1):19-23.
King RE (1975). Tablets in Remington's Pharmaceutical Sciences, 15th Ed. Mack Pub. Coy. Easton, Pennsylvania. p. 1587.
Meadows BA (1988). Ginger Processing for Food and Industry In: Njoku, B.O. (Ed) Proceedings of the First National Ginger Workshop, October 17-21, Umudike, Nigeria, Shanks International Lagos.
Nasipuri RN (1979). Evaluation of Cocoyam Starch as Tablet Binder and Disintegrant Acta Pharm Helv. 54(2): 48-53.
Staniforth JN (1988). Powder Flow in Aulton ME (Ed.) Pharmaceutics: The Science of Dosage Form Design. Churchill Living Stone, Britain. pp. 601-615.
Trease GE, Evan WC (1972). Pharmacognsoy 10th Edition Ballicre, Tindall, London. pp. 362-629.
Tsige G, Alexander SN (1993). Evaluation Starch Obtained From Esente *Ventricosum* As A Binder and Disintegrant For Compressed Tablets. J. Pharm. Pharmacol 45(307): 317-320.
Wallis TE (1967). Textbook of Pharmacognosy 5th Edn. J.A. Churchill Ltd London. pp. 389-393.
Wells JI, Aulton ME (1985). Reformulation In: Aulton, M.E. (Ed), Pharmaceutics: The Science of Dosage Form Design: Churchill Living Stone, Britain, p. 247.