International Journal of Current Pharmaceutical Research

ISSN- 0975-7066 Vol 3, Issue 2, 2011

Research Article

PREPARATION AND CHARACTERIZATION OF MODIFIED STARCH ISOLATED FROM *AMARANTHUS PANICULATUS* LINN.

SINGH L.[1*], SHARMA V.[1], SHARMA S.[2]

Division of pharmaceutical technology, Department of pharmacy, SRMSCET, Bareilly, Uttar Pradesh, India [1], Department of pharmacy, Vivek College of technical education Bijnor Uttar Pradesh, India[2] Email: lalit4u78@gmail.com

Received: 04 Nov 2010, Revised and Accepted: 06 Dec 2010

ABSTRACT

A study has been carried out to investigate the binding and disintegrating properties of modified starch, isolated form *Amaranthus paniculatus* Linn (Amaranthaceae). (*Amaranth* starch) .After modifications of *Amaranth* starch (MAS) dissolution profiles were studied. Paracetamol (500 mg) was used as a marker drug and dissolution data of MAS compared with explotab (marketed modified potato starch) (ES) and potato starch (PS) in batches of 200. All the products met the requirement of in vitro parameters like uniformity of weight, assay, friability and hardness as per pharmacopoeial requirements. These product also conform the dissolution specification of USP. The amount of modified *Amaranth* starch (MAS) required as binding and disintegrating agent was three fourth of the amount of maize and potato starch. Therefore modified *Amaranth* starch can be effectively used in tablet technology.

Keywords: Modified *Amaranth* starch, maize and potato starch

INTRODUCTION

Amaranthus paniculatus linn. (family amaranthaceae) is commonly known as `rajgira', ` rajagiri' the amaranthaceae family consists of hardy, weedy, herbaceous, fast growing, cereal-like plants, with a seed yield of up to 3 tons/hectare.

Amaranth belongs to the so-called improper cereals (pseudo-cereals) and called the third millennium crop-plant due to its high nutritional value and modest demands at growing.

For its features amaranth is important as prevention for people of all ages. Lysine has a unique meaning for small children (it supports the production of brain cells) and minerals, vitamins, unsaturated fatty acids, quality protein for sportsmen, which support the growth of muscular matter. Amaranth recovers cells and influences metabolism significantly.

Amaranth grains contain 7% of oil, where a high portion of essential fatty linoleic acid (70% unsaturated fatty acids) and essential squalene (6.5%) is present high protein content (17%) gluten free, dietary fiber (1.5%) and high contact of minerals (Ca, K, P, Fe) put amaranth on remarkable place in comparison to the other plants.

Although a large number of disintegrants and binders are available. Starches have an important place in the technology of tablets. Usually maize starch is used abundantly. But there is always enough space for developing newer agents to be used in tablet technology for better result. In view of this the present study was carried out for isolation, modification and characterization of starch from *Amaranthus paniculatus* .Studies on optimization of condition for carboxymethylation of amaranth starch has been reported earlier by Bhattacharya *et al* [1].

MATERIAL METHODS

Plant material

Well identified seeds of *Amaranthus paniculatus* were collected from local market, Bareilly.Seeds were identified according to the description of the Wealth of India (Council of Industrial and Scientific Research, Government of India, New Delhi, 1985) and macroscopic comparison was done for authentification of the samples at laboratory of College, where a voucher specimen is deposited.

Isolation procedure

The grains of *Amaranthus paniculatus* were thoroughly washed with water to remove any dirt or adherent material. The grains ware then dried and coarsely ground in a mixer grinder and passed through 22-mesh sieve. These coarsely ground grains were extracted repeatedly with 0.25% sodium hydroxide in a ratio of 1:5, until seeds became free from proteins(tested with Biuret reagent).

The protein free grains were washed continuously for 2 hrs with distilled water till free from sodium hydroxide and proteins. The residue was transferred to the grinder and ground with water to obtain a white paste of starch and fiber. Filtration was done through bolting cloth of 200-mesh size. Filtrate was collected and kept for sedimentation. The sediment obtained was subjected to centrifugation at 6000 rpm for 15 min. The upper brownish layer was scraped and remaining white layer was transferred in the tray dryers and dried at 45^0 C for 5hrs. The dry starch obtained was passed through 60 mesh.

Modification of isolated starch[1]

Sodium carboxy methyl starch (CMS) is prepared by the reaction of starch with sodium monochloroacetate in presence of sodium hydroxide and in presence of organic solvent (isopropyl alcohol) based on Williamson Ether synthesis. And mechanics is essentially SN_2 (Substitution nucleophilic bimolecular).

Starch – OH +Cl CH_2 COONa +NaOH → Starch - OCH_2 COONa +Nacl +H_2O

Starch Sodium monochloro acetate → Carboxy methyl starch

Multistage carboxymethylation of the starch[1]

The second stage carboxymethylation was done of the sodium CMS obtained from first stage as under the same conditions (requirements) as were in first stage. Similarly third stage carboxymethylation was carried out using starch obtained after second stage as a raw material but in the third stage, starch was getting gelatinized there for only double modification was done.

Modified starch also complies with all the pharmacopoeial specifications except pH and residue on ignition.

Test for granule strength and flow property of the granules prepared by modified Amaranth starch

After preparation of Paracetamol granules with MAS, ES and PS granule strength were measured as method described by Carr *et al.* (1965)[2].

Flowability and angular properties of the granules were determined by as described by Train *et al.* (1958)[3].

Preparation and evaluation of tablets [4, 5]

Paracetamol tablets by using different starches (MAS, ES, PS) were prepared by wet granulation method [5].The tablets of 200 batch size each were punched using single punch machine (Cadmach, U.K). The weight variation, test for hardness, friability, disintegration time, uniformity of content and *In–vitro* release pattern tests were performed according to pharmacopoeial specifications.

In –vitro release pattern [6, 7]

In- vitro release pattern in. phosphate buffer (pH 7.4) were determined by using apparatus 1 according to USP XXII and procedure followed as described in USP XXII Values of cumulative percent drug dissolved at various time intervals were also found out and plotted against time. Values of t_{50} (time for 50% dissolution) and t_{70} (time for 70% dissolution) and t_{90} (time for 90% dissolution) were determined from this plot.

Statistical analysis

The data were analyzed using non-parametric Mann-Whitney U-test. The Pearson Chi- square test was used for comparing the granule strength uniformity of weight, hardness, dissolution rate between all the groups where potato starch used as a positive control. The data was expressed as mean ± S.D and a *p*- value of <0.05 was considered statistically significant.

Table 1: Tablet formulation using starch as disintegrant

Formulation	Ingredients (mg/tablet)				
	Paracetamol	Lactose	PMAS	PPS	PES
$PMAS_1$	500	7.0	53.0	-	-
$PMAS_2$	500	33.5	26.5	-	-
$PMAS_3$	500	46.75	13.25	-	-
PPS_1	500	7.0	-	53.0	-
PPS_2	500	33.5	-	26.5	-
PPS_3	500	46.75	-	13.25	-
PES_1	500	7.0	-	-	53.0
PES_2	500	33.5	-	-	26.5
PES_3	500	46.75	-	-	13.25

PMAS is tablet using modified amaranth starch as disintegrant, *PPS* is tablet using potato starch as a disintegrant, *and PES* is tablet using explotab as a disintegrant.

Table 2: Granule strength as a function of granule size prepared with modified *Amaranth* starch

Granules prepared with Amaranth starch for tablet	Breaking load (g)	Midrange or granule size (mm)
Paracetamol	700±4.5 [a]	1.0± 0.030 [a]
(500 mg)	830±4.1 [a]	1.5± 0.048 [a]
	941±5.6 [a]	2.0± 0.091 [a]

* Mean ± S.E.M , n=6. [a] Significantly different from control (P < 0.01); [b] Significant different from starch (P < 0.01).

Table 3: *In vitro* evaluation of various tablets using different starches as disintegrant

Formulation	Uniformity of weight		Assay(percent of labeled amount)	Hardness (kg/cm^2)±SD	Friability %±SD	Disintegration time (s)
	Average wt.(mg)	Maximum %deviation				
$PMAS_1$	598.3± 3.56 [a]	3.6± 0.030 [a]	102.6 ± 7.98 [a]	4.8±0.09 [a]	0.2±0.01 [a]	113± 5.05 [a]
$PMAS_2$	596.5± 17.89 [a]	3.8± 0.29 [a]	101.33± 6.23 [a]	4.6±0.06 [b]	0.2±0.03 [b]	121± 4.87 [b]
$PMAS_3$	597.3± 24.98 [a]	4.1± 0.39 [b]	98.6± 4.98 [a]	4.3±0.05 [a]	0.12±0.01 [b]	129± 3.23 [b]
PPS_1	593.4± 25.27 [b]	4.2± 0.40 [a]	101.33± 2.19 [b]	4.5±0.02 [s]	0.5±0.04 [a]	159± 7.09 [a]
PPS_2	596.3± 13.49 [b]	4.2± 0.33 [a]	104.0± 3.85 [b]	4.1±0.02 [a]	0.4±0.03 [a]	173± 3.33 [b]
PPS_3	595.5± 23.91 [b]	4.5± 0.51 [a]	98.6± 3.97 [a]	4.3±0.02 [a]	0.7±0.02 [b]	183± 4.20 [a]
PES_1	583.6± 17.98 [a]	3.7± 0.29 [a]	102.6 ± 3.25 [a]	3.8±0.06 [b]	0.3±0.00 [a]	138± 6.12 [a]
PES_2	586.7± 23.43 [b]	3.9± 0.41 [a]	97.81± 3.45 [b]	4.6±0.08 [b]	0.36±0.03 [b]	151 ± 3.98 [b]
PES_3	579.5± 19.98 [b]	4.0± 0.59 [a]	102.8 ± 3.45 [a]	4.1±0.05 [a]	0.38±0.01 [b]	162± 4.16 [a]

* Mean ± S.E.M , n=6. [a] Significantly different from control (P < 0.01); [b] Significant different from starch (P < 0.01).

Table 4: Dissolution parameter of Paracetamol tablets containing different starches as disintegrant

Formulation	t_{50}(min)	t_{70}(min)	t_{90}(min)
$PMAS_1$	13.0± 0.28 [a]	24.3± 0.41 [b]	38.9± 0.74 [b]
$PMAS_2$	14.2± 0.56 [a]	25.9± 0.87 [b]	45.8± 0.65 [a]
$PMAS_3$	17.3± 0.45 [a]	28.1± 0.58 [b]	44.7± 0.52 [b]
PPS_1	5.0± 0.78 [a]	10.9± 0.81 [a]	27.9± 0.69 [a]
PPS_2	7.0± 0.59 [a]	12.9± 0.44 [a]	29.9± 0.71 [b]
PPS_3	8.5± 0.25 [a]	13.8± 0.65 [a]	33.5± 0.98 [a]
PES_1	6.5± 0.41 [b]	15.9± 0.55 [a]	41.6± 0.47 [a]
PES_2	9.0± 0.32 [b]	17.3± 0.63 [a]	36.5± 0.55 [a]
PES_3	10.9± 0.49 [b]	20.0± 0.87 [a]	34.4± 0.51 [a]

* Mean ± S.E.M, n=6. [a] Significantly different from control (P < 0.01); [b] Significant different from starch (P < 0.01).

RESULTS AND DISCUSSIONS

Formulations and manufacturing processes have significant effects on the disintegration, dissolution and other physico-chemical characteristics of the dosage form. It should be noted however that the rates of the process of dissolution are all dependent up on the composition and method of preparation of dosage form[8].Modified *Amaranth* starch met the requirement of the test for the absence of *E.coli* and *Salmonella* as per pharmacopoeial specifications[9].The estimation of granule strength is aimed at estimating the relative magnitude of attractive forces seeking to hold the granules together. The resultant strength of granule depends upon the base material, the kind and amount of granulating agent used and granulating equipment. Granule strength affects the changes in particle size distribution of granulations and consequently compressibility into cohesive tablets[11]. In case of modified amaranth starch, granule strengths of different formulations as a function of granule size are shown in Table-2. Several factors and granule characteristics have been studied for their effect on the angle of repose, such as, practical size, use of glidant, moisture effect and particle shape[10]. In our case in all the formulations the values for angle of repose was less than 30^0 which indicate that the granules prepared with amaranth starch as well as other starches used in the formulation were free flowing. Study of the physical parameter of the tablets reveals that all the categories of tablets prepared with different starches met the Pharmacopoeial requirement of uniformity of weight (I.P.)[9] (Table-3).

Values of maximum percent deviation were well within the pharmacopoeial limit. All the products conformed to the requirement of assay (Table-3) as prescribed in the monograph[9]. Hardness of the tablets was within pharmacopoeial limit (Table-3) in all cases. The friability study shows that the friability was with in the order of MAS < MES <PS. The study on the disintegrating property of all the tablets prepared with different starches revealed that the disintegration time in the tablets prepared with MAS was less than that of Explotab and Potato starch (Table-3). So the result of these studies showed that modified *Amaranth* starch has got good disintegrating and binding property. One point dissolution data (as per requirement of USP[7]) of all the products are shown in Fig. 1, 2 and 3.

All the products met the dissolution requirement of USP i.e. each product of Paracetamol tablet shows not less than 80% dissolution at stage S_1 of dissolution test. Values of t_{50}, t_{70} and t_{90} of all products are indicated in (Table-4) from these values it is clear that tablets prepared with modified *Amaranth* starch showed fastest dissolution rate. However as mentioned above, all the products confirmed to the one point dissolution test specified in USP[7]. Thus from the results so far obtained it can be concluded that modified *Amaranth* starch has got better binding, disintegrating property and dissolution characteristics therefore can be exploited for commercial use.

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