study. Kiil et al (1969) also reported no effect of acetylcholine on renal blood flow autoregulation. However, they observed that the high dose infusion of acetylcholine abolished renal autoregulation. They explained this phenomenon by application of Poiseuille's law on the premise that acetylcholine acted mainly on muscle elements other than those participating in autoregulation.

We have observed that nitroglycerin, nicorandil, sodium nitroprusside and sodium nitrite, which are believed to relax smooth muscle through the activation of guanylate cyclase, had no effect on the autoregulation (Ogawa & Ono 1986). Furchgott & Zawadzki (1980), and Murakami et al (1985) reported that acetylcholine- and carbachol-induced relaxation of vascular smooth muscle was due to the endothelium-derived relaxing factor (EDRF) which is released from endothelial cells. Furthermore, some investigators have shown that EDRF produces an increase in cGMP by stimulation of guanylate cyclase in vascular smooth muscle (Furchgott et al 1981; Rapoport & Murad 1983; Ignarro et al 1984). If renal vasodilation induced by the infusion of acetylcholine and carbachol into the renal artery is mediated by increase of cGMP, the present results are supported by our previous data showing that vasodilators that relax smooth muscle through cGMP did not abolish renal autoregulation.

Ono et al (1974) showed that the intrarenal infusion of verapamil (30 $\mu g\ min^{-1}$) or nifedipine (3 $\mu g\ min^{-1}$) abolished renal autoregulation in spite of not showing vasodilating action at low perfusion pressure. Thus, there does not seem to be a direct correlation between the vasodilating mechanism and the autoregulatory mechanism. In our present experiment, the lack of influence of acetylcholine and carbachol on the autoregulation cannot be accounted for by insufficiency of the doses used. Due to the negative finding of our study, we concluded that muscarinic receptors do not contribute to the mechanism of autoregulation of renal blood flow.

REFERENCES

Furchgott, R. F., Zawadzki, J. V. (1980) Nature 288: 373–376

Furchgott, R. F., Zawadzki, J. V., Cherry, P. D. (1981) in: Vanhoutte, P. M., Leusew, I. (eds) Vasodilation, Raven Press, New York, pp 49–66

Hashimoto, K., Ono, H., O'Hara, N. (1980). in: Fleckenstein, A., Roskamm, H. (eds) Calcium-antagonisms, Springer-Verlag, Berlin, Heidelberg and New York, pp 221–229

Ignarro, L. J., Burke, T. M., Wood, K. S., Wolin, M. S., Kadowitz, P. J. (1984) J. Pharmacol. Exp. Ther. 228: 682–690

Kiil, F., Kjekshus, J., Löyning, E., (1969) Acta Physiol. Scand. 76: 10–23

Murakami, K., Karaki, H., Urakawa, N. (1985) Jap J. Pharmacol. 39: 357–364

Nahmod, V. E., Lanari, A. (1964) Am. J. Physiol. 207: 123–127

Ogawa, N., Ono, H. (1985) Jap. J. Pharmacol. 39: 349–355

Ogawa, N., Ono, J. (1986) Ibid. 41: 299–306

Ono, H., Kokubun, H., Hasimoto, K. (1974) Naunyn-Schmiedeberg's Arch. Pharmacol. 285: 201–207

Rapoport, R. M., Murad, F. (1983) Circ. Res. 52: 352–357

Semple, S. J. G., DeWardener, H. E. (1959) Ibid. 7: 643–648

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Evaluation of sorghum starch as a tablet disintegrant and binder

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The starch prepared from the seeds of *Sorghum bicolor*, Moench has been evaluated as a disintegrant and binder in tablets of magnesium sulphate, calcium carbonate, sulphadimidine, and chloroquine phosphate to represent soluble and insoluble inorganic and organic substances. The starch performed as well as maize starch in binding and disintegrating properties and better than acacia as binder.

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While starch from different plants is an adjuvant in the formulation and production of solid dosage forms, starch from sorghum, a food crop widely grown in tropical Africa, including Nigeria, appears not to have been used as a tablet excipient. We have examined its usefulness both as a binder and as a disintegrant for the formulation of tablets containing inorganic and organic medicinal substances and compared the physical characteristics of the tablets with those prepared using acacia as a binder and maize starch as binder/disintegrant. Magnesium sulphate and calcium carbonate were used as soluble and insoluble inorganic substances, and sulphadimidine and chloroquine phosphate as insoluble and soluble organic substances, respectively.

Materials and methods

Sulphadimidine (May & Baker Ltd, UK) and chloroquine phosphate (Bayer Nigeria Ltd) were of BP grade. Maize starch and acacia were from BDH Chemicals Ltd and May & Baker Ltd UK, respectively.

Sorghum starch was prepared in our laboratory from the seeds of sorghum (*Sorghum bicolor*, Moench)

washed once and dried in air. They were milled then reduced to fine pulp by a blender after mixing with water. The pulp was passed through calico to remove extraneous matter and the starch was allowed to settle. It was washed several times with 0·1 M sodium hydroxide and then with purified water. The product was reduced to a fine powder. The starch grains were oval and mostly single having a diameter of 2–11–18 μm.

The tablets were formulated to contain either 500 mg of sulphadimidine or 200 mg of chloroquine phosphate, or 300 mg of either magnesium sulphate or calcium carbonate. Three different binders and two different disintegrants were used for each substance. After granulation, the dried granules were evaluated for moisture content using a Mettler LP 12 moisture determination balance. The lubricated granules (the lubricant was equal parts of talc and magnesium stearate) were compressed using an Erweka single punch tablet machine at 50 MNm^{-2} compaction pressure. All the formulations were evaluated for hardness, friability values, disintegration time. Dissolution rate tests were conducted only on sulphadimidine and chloroquine phosphate tablets.

Hardness was determined by the Erweka hardness tester, friability values were obtained with the Roche friabilator. The disintegration times of tablets were determined by the BP 1980 method using an Erweka tablet disintegration test unit. Dissolution rates were measured with an Erweka dissolution rate tester, with a rotating basket type assembly in which the medium was 500 mL distilled water at 37 ± 0·5 °C; the rotation speed was 100 rev min^{-1}. Released drug was measured spectrophotometrically. The dissolution tests were in triplicate.

Results and discussion

The moisture contents of the granule samples varied from 0·9 to 1·6% w/w. After six months of storage at room temperature (range 20 to 37 °C), both the friability and the hardness (3·5–6·0 kg cm^{-1}) of all the formulations were similar to initial values. The disintegration time of tablets immediately after compression, as well as after storage, indicated that, irrespective of drug used formulations prepared with acacia as binder showed slower disintegration rates compared with tablets prepared using starches as binder (Table 1).

Tablets prepared using sorghum or maize starches showed similar disintegration times and both were better binding agents that acacia. The rate of dissolution of sulphadimidine and chloroquine phosphate from tablets prepared with sorghum starch as binder/disintegrant (Table 2) was better than that of tablets prepared with maize starch as binder/disintegrant, even after six months. When the results of sorghum and maize starches were compared, the tablets prepared with sorghum starch as disintegrant and acacia as binder showed the fastest dissolution rate when freshly prepared.

Table 1. Disintegration time of tablets. A, fresh and B, stored (6 mth at 20–37 °C) tablets. * Mean of 2 × 6 tablets.

Tablets	Binder	Disintegrant	Distintegration time (min)** A	B
Sulphadimidine	1	a	1·66	1·46
	2	a	9·42	12·34
	3	b	1·86	1·52
	2	b	10·42	14·30
Chloroquine phosphate	1	a*	0·73	0·64
	2	a*	5·42	8·34
	3	b*	0·84	0·71
	2	b*	6·53	9·82
Magnesium sulphate	1	a*	0·87	4·82
	2	a*	6·74	12·42
	3	b*	0·92	5·08
	2	b*	5·62	13·40
Calcium carbonate	1	a	1·02	0·92
	2	a	4·62	5·82
	3	b	1·12	0·86
	2	b	4·34	5·18

Binder
1 = Sorghum starch paste 10% w/w
2 = Acacia mucilage 20% w/w
3 = Maize starch paste 10% w/w

Disintegrant
a = Sorghum starch 10%
b = Maize starch 10%
a* = Sorghum starch 5%
b* = Maize starch 5%

Table 2. Dissolution times of A, fresh and B, stored (6 mth, at 20–37 °C) tablets. * Mean of 2 × 6 tablets. Binders and disintegrants as Table 1.

Tablets	Binder	Disintegrant	Dissolution time (min) T50 A	T50 B	T90 A	T90 B
Sulphadimidine	1	a	8	6	14	8
	2	a	3	12	8	18
	3	a	18	20	36	38
	2	b	8	14	14	32
Chloroquine phosphate	1	a*	3·5	4·0	8	7
	2	a*	2·4	5·0	5·6	5·0
	3	b*	4·2	4·0	8·2	7·6
	2	b*	3·0	3·2	5·6	6·2

From the results, it is concluded that sorghum starch may be used as binder as well as disintegrant for the formulation of tablets containing both soluble and insoluble drugs. It is equally as good as maize starch in its binding and disintegration properties, and it is better than acacia for binding since dissolution times were shorter, particularly after ageing.

REFERENCE

British Pharmacopoeia (1980) Her Majesty's Stationery Office, London, Vol. 2, Appendix XIIA A 113