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Oxidised starch as gum arabic substitute for encapsulation of flavours

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Abstract

Oxidised starches prepared from corn and waxy amaranth starch under conditions optimised for development for film forming ability were compared with gum arabic and a known substitute of gum arabic for encapsulation of a model flavour compound, vanillin. Percentage vanillin encapsulated using gum arabic, amiogum 688 (a known gum arabic substitute), oxidised corn starch and oxidised amaranth starch differed marginally and were found to be 57.84%, 58.61%, 60.89% and 58.61% respectively of the recoverable vanillin. Results obtained suggest the possibility of using oxidised starch as a substitute for gum arabic in encapsulated flavours with advantages such as freedom from hygroscopicity and similar encapsulation efficiency.

Keywords: Encapsulation; Oxidised starch; Gum arabic substitute

1. Introduction

The striking film forming property of oxidised starch renders it as a wall material for encapsulated flavours. Among the several wall materials, gum arabic is a preferred encapsulating agent for spray dried flavours. It has an added advantage of lasting 10–20 times longer than flavours air dried on a solid carrier like sugar (Wenneis, 1956; Glicksman, 1983). Traditionally, supplies of gum arabic have relied on availability by natives of subequatorial regions, such as from Sudan. However, several West African countries, particularly Senegal, are establishing plantations of selected species in order to regularise the supplies. In times of shortages, such as those which occurred in the early and mid-1970s, efforts were made to find a replacement for gum arabic. Some modified starches were found to be suitable, but a satisfactory replacement was far from available.

Oxidation of starch with di- or tetra-chloro glycouril in sodium carbonate reportedly gives an excellent film (Bozel, 1968). Optimisation of parameters for oxidation of corn and amaranth starch with a view to obtaining film forming properties was studied recently in our laboratories (Chattopadhyaya et al., 1997). The present work aims at utilising these oxidised starches prepared from corn and waxy amaranth starch for encapsulation of a model flavour compound, vanillin, in comparison with gum arabic and a known gum arabic substitute, Amiogum 688.

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2. Materials

Oxidised corn and amaranth starch were prepared as described earlier (Chattopadhyaya et al., 1997). Gum arabic and propylene glycol were procured from M/S Loba Chemie Pvt. Ltd., Mumbai. Amiogum 688 was obtained as gift sample from M/S American Maize Products Co., USA. Vanillin was procured from M/S S.M. Dye Chem. Ltd., Mumbai. All other reagents used were of analytical grade.

3. Methods

3.1. Preparation of the encapsulated vanillin

20% solutions of gums and oxidised starches were prepared at 98°C with constant stirring for 2 min using a mechanical stirrer. Since vanillin is not soluble in water beyond 1%, solutions were prepared using a minimum amount of propylene glycol. The amount of vanillin added was at 10% of the weight of the oxidised starches or gums used. The resultant solutions were spray dried on a laboratory Buchi mini spray drier using 160 ± 10°C as inlet temperature for gum arabic and 115 ± 10°C for the oxidised starches and amiogum 688. The outlet temperature in all cases was 75 ± 10°C.

3.2. Analysis of the encapsulated vanillin (North, 1949)

3.2.1. Preparation of standard curve of vanillin

A standard solution of vanillin (10 mg/100 ml) in water

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Table 1
Encapsulation of vanillin by oxidised corn and amaranth starches compared with gum arabic and its substitute[a]

Encapsulating agent[b]	Product appearance and colour	Total vanillin recoverable (%)	Vanillin encapsulated (%)[c]	Surface vanillin (%)[c]
Gum arabic	off-white, hygroscopic powder	74.80 ± 0.23	57.89 ± 0.27	42.11 ± 0.27
Amiogum 688	white, free flowing powder	72.61 ± 0.37	58.61 ± 0.43	41.39 ± 0.43
Oxidised corn starch	white, free flowing powder	81.41 ± 0.25	60.89 ± 0.23	39.10 ± 0.23
Oxidised amaranth starch	white, free flowing powder	81.41 ± 0.35	58.61 ± 0.48	41.39 ± 0.48

[a] Values are mean ± SD of three determinations.
[b] Used at 20% concentration.
[c] Based on the recoverable vanillin.

was prepared and, from this, dilutions in the range 0.001 to 0.01 mg ml^{-1} were prepared. To 5 ml of each of these dilute solutions, 5 ml Folin–Denis reagent was added and thoroughly mixed by rotation. The volume was made up to 50 ml with 1 N Na_2CO_3 solution and vigorously shaken for 5 min. After 30 min, the blue colour was read in a Bosch–Lomb Spectronic 20 spectrophotometer at 640 nm.

3.2.2. Estimation of encapsulated and surface vanillin

Surface vanillin represents the vanillin adhered to the surface of the sphere of the encapsulated microgranules, whereas encapsulated vanillin represents vanillin inside the spheres. Since vanillin is soluble in absolute alcohol, the adhered surface vanillin can be recovered by washing the spray dried microgranules with absolute alcohol, which can then be estimated. Since the starch is not soluble in absolute alcohol, the encapsulated vanillin will not interfere.

For estimating encapsulated vanillin and surface vanillin, 0.25 g of each powdered sample was washed with 25 ml of absolute alcohol and the filtrate volume made up to 50 ml with water. The residue was dissolved in distilled water and the volume made up to 100 ml. Vanillin was estimated in 5 ml of each of these samples as described above. The total time required for washing with alcohol, filtration and making alcoholic and aqueous solutions took about 1 h, during which some losses occurred. Hence total recovery of vanillin after dissolving in water was measured. For this, 0.1 g of each sample was made up to 100 ml in a volumetric flask. 5 ml aliquots from each of the diluted samples were analysed as per the method described above.

4. Results and discussion

The results of encapsulation of vanillin using various wall materials are given in Table 1. 20% concentration of each of these wall materials was used, since a flexible film was obtained at this concentration. There was no appreciable difference in the percentage of vanillin encapsulated, as well as surface vanillin, among the encapsulating agents under study. It can be seen that encapsulation efficiency of oxidised corn and amaranth starch is better than gum arabic and amiogum 688, which is a modified waxy corn starch commercially available as a gum arabic substitute. This is indicated by the percentage of total vanillin recoverable. Hence, although the percentage of encapsulated vanillin appears similar in all cases, the actual amount of vanillin encapsulated is higher for both the oxidised starches than with gum arabic and amiogum 688. In addition, the spray dried vanillin prepared from gum arabic as wall material was found to be hygroscopic. Amiogum 688 and both the oxidised starches were, however, free flowing. Both corn and amaranth starch showed similar efficiency as wall materials for encapsulation, the flavour recovery being around 81%. Information on such aspects of oxidised starch is scanty. Starch-based encapsulation processes have been patented (Eden et al., 1989). Use of gum arabic substituted modified starch (Miyazaki and Endo, 1986) for spray dried flavour encapsulation is also reported (Bangs and Reineccius, 1988).

The results of this study reveal the potential of oxidised starch as a substitute for gum arabic in encapsulated flavours, especially for countries importing it.

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