Journal of Scientific & Industrial Research
Vol. 63, October 2004, pp 826-829

Effects of different treatments on physico-chemical properties of rice starch

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Received 03 January 2004; accepted 06 August 2004

The physico-chemical property of rice starch depends on the gelatinization of starch under different treatments. Three different gelatinization processes were performed –boiling in water, steam heating, and enzymatic digestion. The effects of gelatinization on viscoelastic property of rice starch were measured by Instron Texture Analyser (London, UK). The 3-*D* structural changes of rice starch after different treatments were determined by SEM. Various grooves and fissures on the exterior surface of the granules were noticed in the treated sample compared to control.

Keywords: Rice starch, Gelatinization, Steam heating, Texture, SEM
IPC Code: **Int. Cl.**[7]: C 12 P 7/10

Introduction

There is no more important crop in the world today than rice[1] (*Oryza sativa*). It is a staple food for the growing millions of South East Asia, whose numbers are increasing rapidly. Rice is consumed largely in the cooked form[2]. It is also nutritious and hypoallergenic[3] which make rice products staple food ingredients. Also some unique functional properties[4-6] of rice such as, flavour carrying capability, hypoallergenicity etc.make it a grain for use in many value added products. Some examples of these products include gluten free bread, beverages, processed meat, low fat sauces, puddings or salad dressing.

Starch is the primary component of rice flour and consequently plays an important role as a determinant of the food product quality. Functional properties of starch have considerable effects on the quality of starch-based products.Starch gelatinization[7] is most important in many food modifications inclusive cooking, baking and extruding starch-based foods. The overall starch gelatinization process is generally supposed to obey a first order kinetics[8] and depends on temperature. Nonetheless the phenomenon is very complex and implies significant changes in physical, chemical, and nutritional properties of starch as well as water and heat diffusivity, viscosity, rheological behavior, swelling and deformation of the original shape of starchy products and susceptibility to enzymatic digestion. In fact the crystalline order of starch granules is lost during gelatinization[9]. Therefore, starch gelatinization is a dynamic procedure that involves disruption of molecular order within the starch granule[10].Extrusion[11] technology is widely used to make starch based extruded products with low cost and high efficiency. Degree[12] of starch gelatinization is dependent on the parameter of extrusion.The present paper has studied the effect of different treatments on gelatinization of rice starch, which affects viscoelastic property. The viscoelastic properties of starch-based doughs were measured by InstronTexture Analyser (London, UK). Scanning electron microscope (SEM) was applied to observe the 3-*D* structural changes of rice starch after different treatments.

Materials and Methods

Rice of atap variety (Oryza sativa .L, Patnai) [1] was procured from local market. Wheat flour was also collected from local market. α- amylase (pure) was purchased from Sigma Chemical Co. (St Louis, Mo.) 3,5 dinitrosalicylate was purchased from Loba Chemie (Mumbai).

Different Treatments on Rice Starch

(i) White rice (Atap) was used throughout the experiments. Rice was treated in boiling water for 5,10,15min followed by drying at 60 °C in tray drier for 5-6 h.

(ii) Another portion of rice was steam heated at 15 psig for 10,20 and 30 min before drying at 60 °C for 5-6 h.

(iii) Beside steam heating another portion of rice was treated with amylolytic enzyme and then dried at 60 °C for 5-6 h.

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Table 1—Composition of recipe1 and 2

Ingredients	Recipe 1	Recipe 2
Rice (per cent)	30	25
Wheat flour (per cent)	15	20
Bengal gram powder (per cent)	15	15
Soy powder (per cent)	10	10
Water (per cent)	25	25
Oil (per cent)	5	5

Developments of Dough

All the dried samples were milled finally and used for dough development. Two different recipes (Table 1) were made for dough preparation. The proportion of wheat flour and rice was kept constant in each case.

Moisture Content

Moisture content of whole grain and treated rice was measured, using standard air oven according to AOAC[13]

Texture Analysis

Texture analysis of all the doughs were made using Instron Texture Analyser4301 (London, UK).

SEM

Scanning electron microscope (JEOL, JSM5200, Tokyo, Japan) were used at an accelerating voltage of 20 km to view the rice starch in three dimensions and to determine the shape and surface features of starch granules. Rice starch granules from all the treatments and the control samples were mounted stubs with adhesive tape and sputters coated gold approx. 190Å thick for 2.5 min at 10mA before observation with SEM. One micrograph was taken for each starch sample at 1000X magnification. All the images for each sample showed representative results.

Determination of Starch DamageEffects of different treatments on rice starch damage were estimated by determining reducing sugar (Maltose) content of each sample. Reducing sugar content was determined by standard AOAC[13] method.

Results and Discussion

Fig. 1 and 2 show the viscoelasticity of doughs for recipe1 and recipe2, respectively. It is evident from the figures that viscoelasticity of doughs prepared from rice under different treatments were influenced by starch damage. It has also been found that in the case of boiling and enzymatic digestion, the viscoelasticity of doughs decreased highly (For recipe 1 stress values are: 0.7*N*, 1.5*N*, 2.25*N* for 5,10,15 min boiling and 1.23*N*, 1.68*N* for 0.06 per cent and 0.075 per cent enzyme concentration, respectively. For

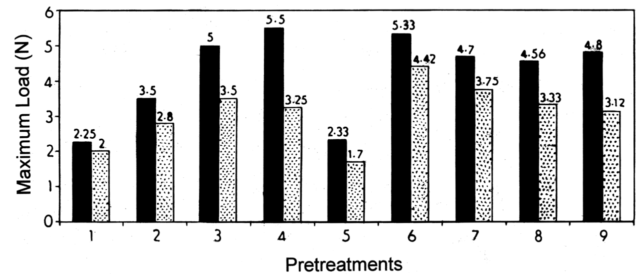

Fig. 1 —Texture analysis of doughs for recipe 1

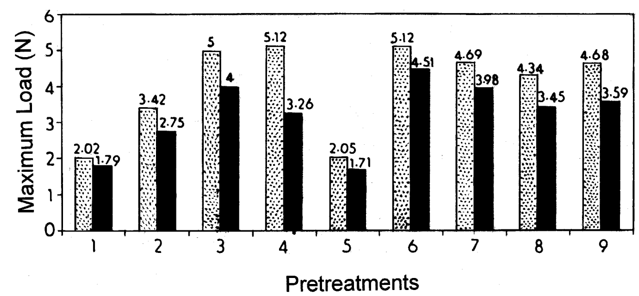

Fig. 2—Texture analysis of doughs for recipe 2, Pretreatments: 1 Control (P1), Boiling in water for 5 min (P2), Boiling in water for 10min(P3), Boiling in water for 15 min (P4),10 min steam heating at 15 psig (P5), 20 min steam heating at 15 psig (P6), 30 min steam heating at 15psig(P7), Enzymatic digestion at enzyme concentration 0.06per cent (P8), 9 Enzymatic digestion at enzyme concentration 0.075per cent (P9)

recipe 2, stress values are: 0.67*N*, 1*N*, 1.86*N* for 5,10,15 min boiling and 0.89*N* and 1.09*N* for 0.06 per cent and 0.075 per cent enzyme concentration, respectively) than that of steam treatment (for recipe 1 stress value are: 0.63*N*, 0.91*N*, 0.95*N* for 10,20,30 min at 15psig and for recipe 2 stress value are: 0.34*N*, 0.61*N* and 0.71*N* for 10,20,30 min at 15 psig, respectively).

SEM pictures illustrate the effects of different treatments on the external structure of the individual starch granules compared to control (Fig. 3). SEM showed that the rice starch granules under various treatments differed in shape from control one. Various grooves and fissures on the exterior surface of the granules are noticed in the treated samples compared to control. During different treatments on starch, maltose (reducing sugar) is freed from rice starch to a great extent. Thus the starch damage during different treatments is determined by measuring percentage maltose content of each sample, which is shown in Fig. 4. Rice starch treated for 15min in boiling water shows the maximum maltose content (10.96 per cent) while steam-heated sample at 10min shows the minimum value (6.14 per cent).

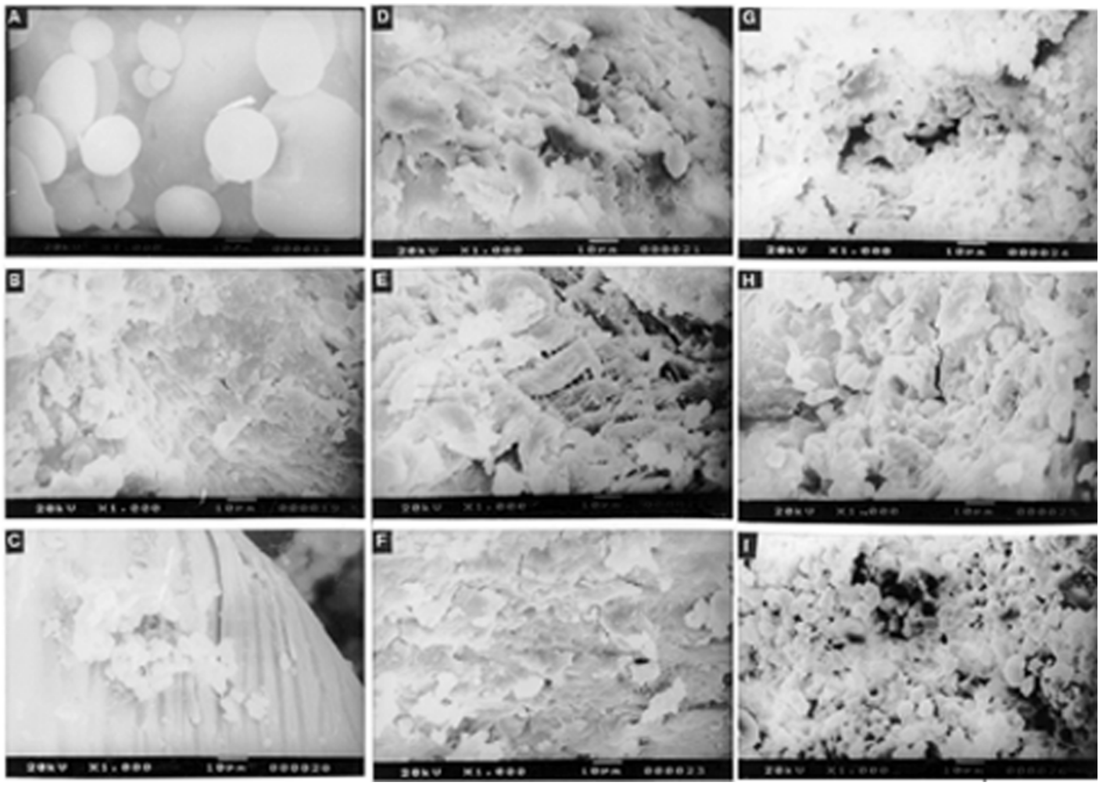

Fig. 3—Scanning electron microscopy pictures :A: P1, B: P2, C: P3, D: P4, E: P5, F: P6, G: P7, H: P8, I: P9

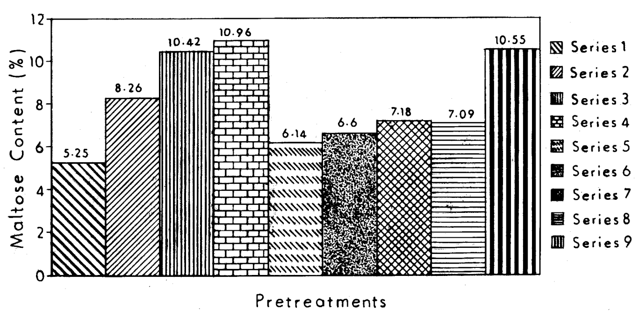

Fig. 4—Determination of maltose content (per cent) Series 1: P1, Series 2: P2, Series 3: P3, Series 4: P4, Series 5: P5, Series 6: P6, Series 7: P7, Series 8: P8, Series 9: P9

Conclusions

Viscoelasticity, starch damage, per cent maltose content and surface structure of rice starch are influenced by the action of different pretreatments. Treatments in boiling water and enzymatic digestion show great changes in rice starch compared to steam heated samples.

Acknowledgement

Authors are grateful to Departmental Special Assistance (UGC) for financial support.

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