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Effects of gums on physical properties, microstructure and starch digestibility of dried-natural fermented rice noodles

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ABSTRACT

The effects of gums including carboxymethyl cellulose (CMC), xanthan gum (XG) and guar gum (GG) on physical properties, microstructure and starch digestibility of dried-natural fermented rice noodles were investigated. The gums, each at 0.05 and 0.10 g/100 g wet basis, were added to the flour during rice noodle production. Control was the sample without the addition of gums. Physical properties (color, water absorption, cooking loss and firmness), microstructure, starch composition and in vitro starch digestibility were determined. Generally, the addition of gums improved the physical qualities of rehydrated fermented rice noodles as evidenced by high water absorption and low cooking loss. CMC provided the best result for improvement of the physical properties of rice noodles. The addition of gums promoted the porous microstructure in rice noodles. In terms of starch digestibility, the addition of gums increased the rate of starch digestion and consequently provided high estimated glycemic index (GI). Samples with XG showed the highest starch digestion rate and estimated GI values when compared with CMC and GG. It is concluded that CMC, XG and GG improved the texture and cooking quality of dried-natural fermented rice noodles but they had negative effects on starch digestion rate and estimated GI.

1. Introduction

Rice has been widely used as a primary gluten-free flour base for scientific and industrial purposes. However, there is still a challenge to formulate gluten-free products with rice because rice flour does not have the functionality of structural protein called gluten. It has been recognized that rice dough has low elastic property, weak resistance to stretch, and poor mixing tolerance [1].

Natural fermented rice noodles are popular in many Asian countries. They can be called differently such as sour *Mifen* in China, *Khanom Jeen* in Thailand, *Mohingar* in Myanmar, *Khao Pen* in Laos and *Banh Da* in Vietnam, etc. For most rice noodle factories, fermentation is conducted in large parallelepiped steel tanks at ambient temperature. Tanks are almost completely filled with polished rice grains and covered with a thin layer (8–15 cm) of water. The rice grains are statically fermented naturally, without a starter, for a few days, then wet-milled, steamed, and extruded into rice noodles [2]. Natural fermentation has been reported as a traditional process to improve the textures and enhance sensory properties of rice noodles [3–5]. Lactic acid is the dominant organic acid produced by fermentation. The fermentation of raw milled rice decreased protein and lipid content, increased the purity of rice starch, and thus improved the texture of fermented rice noodles. However, the low molecule weight sugars produced during fermentation weakened the noodle texture [2].

In addition, due to the absence of gluten, freshly-produced fermented rice noodles show relatively poorer cohesive and extensible textural properties when compared to wheat-based noodles. It also contains considerably high amount of water. Therefore, the shelf life of natural fermented rice noodles is very short (a few days). Drying by various techniques is employed to produce dried rice noodles with enhanced shelf life. Dried rice noodles can be reconstituted by boiling in hot water. However, water removal during drying processes severely affects the textural structure of dried rice noodles. It also affects the properties of rehydrated rice noodles.

Several trials have been made to improve the rice noodle properties. The addition of hydrocolloids, such as natural gums, has often been suggested as a potential way to overcome the processing difficulty and functionality of rice starch. Natural and modified hydrocolloids are widely used in noodles and their effects depend on the types and amounts of gum added [6]. The gums in food system can be used to mimic the viscoelastic properties of gluten, thereby leading to improved structure, mouth feel, and acceptability in foods [7]. Guar gum (GG), xanthan gum (XG), locust bean

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Table 1
Textural properties of the rehydrated fermented rice noodles as investigated by color, water absorption, cooking loss and firmness values.

Samples	Color-L*	Color-a*	Color-b*	Water absorption (g/100 g wet basis)	Cooking loss (g/100 g wet basis)	Firmness (g.force)
Control	68.33 ± 0.40d	−0.43 ± 0.06a	4.10 ± 0.10d	194.75 ± 6.12a	1.06 ± 0.03a	44.01 ± 0.43c
CMC005	71.73 ± 0.12b	−0.77 ± 0.06c	3.67 ± 0.12e	231.08 ± 6.85b	0.82 ± 0.06c	47.21 ± 1.06b
CMC010	69.90 ± 0.35c	−0.67 ± 0.06c	3.23 ± 0.15f	257.17 ± 3.00a	0.81 ± 0.05c	45.36 ± 0.41bc
XG005	67.43 ± 0.25e	−0.53 ± 0.05ab	5.17 ± 0.25b	198.88 ± 6.97d	0.93 ± 0.19bc	43.63 ± 0.90c
XG010	68.77 ± 0.40d	−0.63 ± 0.07bc	4.50 ± 0.10c	210.83 ± 3.49c	1.13 ± 0.06a	45.05 ± 1.27c
GG005	71.80 ± 0.26b	−0.73 ± 0.12c	5.80 ± 0.26a	204.32 ± 2.61 cd	0.91 ± 0.04bc	49.19 ± 1.60a
GG010	72.47 ± 0.21a	−0.50 ± 0.10ab	5.60 ± 0.20a	210.77 ± 7.15c	0.98 ± 0.08abc	49.43 ± 1.32a

Note: CMC = carboxymethyl cellulose, XG = xanthan gum, GG = guar gum; 005 = 0.05 g/100 g, 010 = 0.10 g/100 g (wet basis) addition.

gum (LBG), alginates, and carboxymethyl cellulose (CMC) are common stabilizers used in food industry to provide viscosity, improve firmness, and give body and mouth feel to the end product [6,8]. These are probably due to the effects of gums on gelatinization and retrogradation of starch food systems. It has been reported that non-ionic polysaccharides, including GG, LBG and konjac glucomannan, interacted with amylopectin upon heating, leading to increase in paste viscosity. Gums could also increase the effective concentration of amylose and amylose-like component in the continuous phase through their thermal thickening, leading to acceleration of short-term retrogradation. However, they should depress gel properties and inhibit the crystallization of amylose and/or the co-crystallization between amylose and amylopectin, leading to retardation of long-term retrogradation [9].

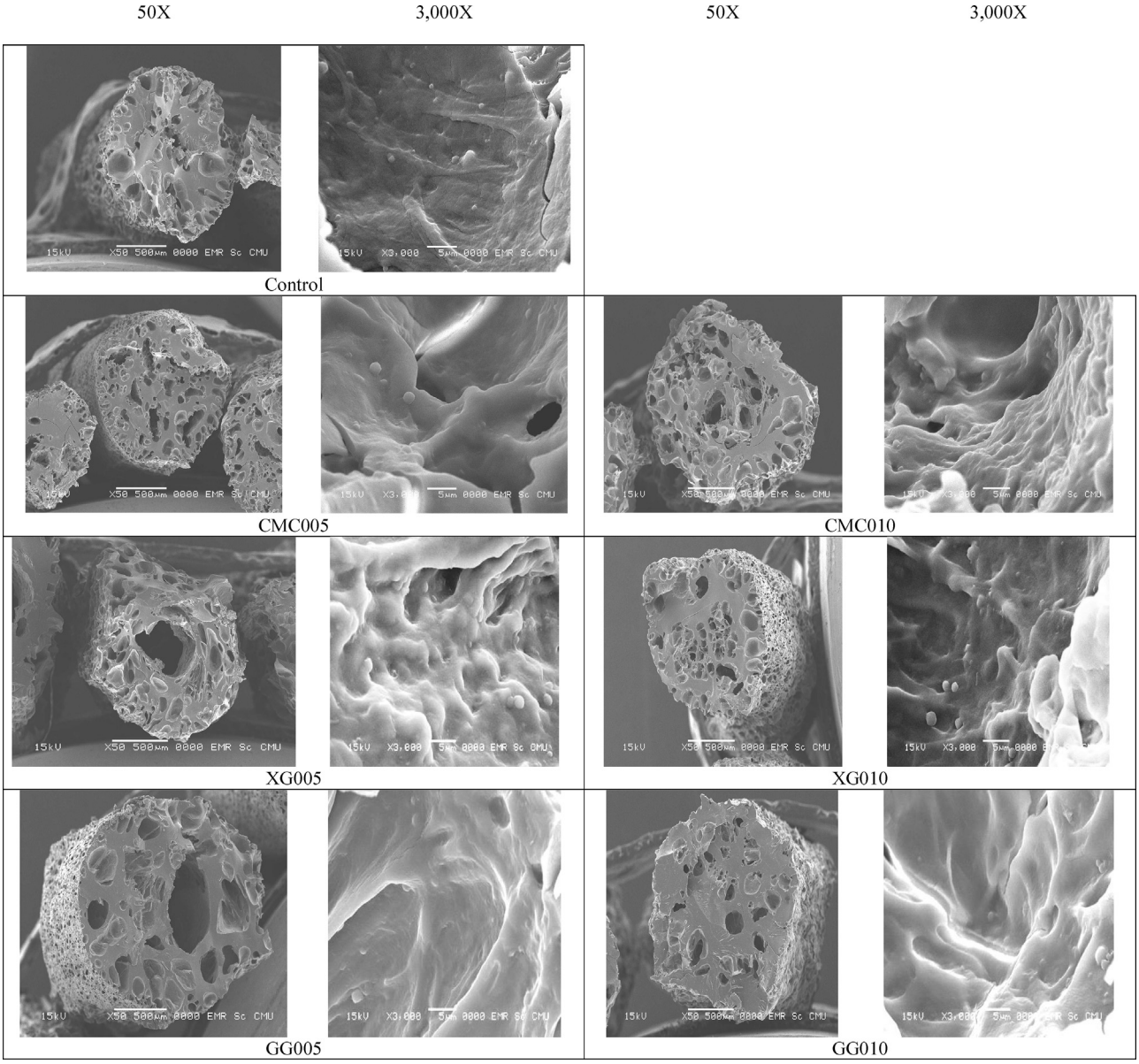

Fig. 1. SEM images of the dried-natural fermented rice noodles (CMC = carboxymethyl cellulose, XG = xanthan gum, GG = guar gum; 005 = 0.05 g/100 g, 010 = 0.10 g/100 g (wet basis) addition).