LWT - Food Science and Technology 97 (2018) 362–369

Contents lists available at ScienceDirect

LWT - Food Science and Technology

journal homepage: www.elsevier.com/locate/lwt

Utilization of Ca^{2+}-induced setting of alginate or low methoxyl pectin for noodle production from *Japonica* rice

Yoko Nitta[a], Yukihiro Yoshimura[a], Natsuki Ganeko[a], Hideyuki Ito[a], Nobuyuki Okushima[b], Masaaki Kitagawa[c], Katsuyoshi Nishinari[d,*]

[a] Department of Nutritional Science, Faculty of Health and Welfare Science, Okayama Prefectural University 111 Kuboki, Soja-shi, Okayama, 719-1197, Japan
[b] Okushimaya Co. Ltd., 966-1 Kamogata, Kamogata-cho, Asaguchi-shi, Okayama, 719-0243, Japan
[c] Keiwa Innovation Co. Ltd., 1 Mitsuishi, Bizen-shi, Okayama, 705-0132, Japan
[d] Glyn O. Phillips Hydrocolloids Research Centre, Department of Food and Pharmaceutical Engineering, School of Light Industry, Hubei University of Technology, Wuchang, Wuhan 430068, China

ARTICLE INFO

Keywords:
Rice noodle
Firmness
Adhesiveness
Slipperiness
Gluten-free

ABSTRACT

Japonica rice is not generally appropriate for noodle production because of its stickiness and lack of firmness. In the present study, effects of Ca^{2+}-induced setting of alginate or low methoxyl (LM) pectin on the firmness and stickiness of *Japonica* rice noodles were investigated. The *Japonica* rice noodles containing alginate or LM pectin showed a sufficient firmness after immersion in calcium chloride solutions judging from a peak force during compression. The firmness indexed by the peak force in the compression test could be increased ten/several times with increasing concentration of alginate/LM pectin and immersion time. Without Ca^{2+} treatment the noodles did not show a clear peak force but just showed a gradual rise in the compression force. The surface stickiness of the noodles was evaluated by the adhesiveness of the newly introduced instrumental method. The adhesiveness of the noodles decreased with increasing alginate or LM pectin concentrations which should lead to a more slippery sensation. Thus the treatment of Ca^{2+}-induced setting of alginate or LM pectin is promising for the gluten–free noodle production from *Japonica* rice.

1. Introduction

Rice, one of major grains especially in Asia, is eaten in various forms including a grain form (cooked rice), a flour paste film or sheet, and a rice flour noodle. The consumption of rice is increasing in Southeast Asia, South Asia, and Africa (Food and Agriculture Organization of the United Nations., 2016) and it has been attracting much attention as an important substitute for people suffering from allergic symptom caused by gluten (Brietzke, Cerqueira, Mansur, & McIntyre, 2018; Jones & Sheats, 2016) and from intolerance (Czaja-Bulsa, 2015). Two types of rice short grain *Japonica* and long grain *Indica* are well known and the former is eaten mainly in the grain form whereas the latter is eaten in various forms, grain form, flour paste film, rice bread, and rice noodle. Cooked rice of short grain type with low amylose content is mainly consumed in grain form because of its soft and sticky texture which are suitable for cooked white rice and *sushi*. Recently consumption of *Japonica* rice is increasing in China, the country with the highest rice production in the world, where the *Indica* rice production is shifted to *Japonica* rice production with growing in economy and change in their liking (Foreign Agricultural Service/United States Department of Agriculture., 2017; Ministry of Agriculture, Forestry and Fisheries of Japan. 2013). Japanese *sushi* boom brought worldwide demand of *Japonica* rice, however in Japan, although almost all of rice produced is *Japonica*, its consumption is decreasing as in other developed countries which is recognized as a general tendency for the decrease of grain consumption (Food and Agriculture Organization of the United Nations., 2016). Ministry of agriculture, forestry and fisheries of Japan tries to increase the consumption of *Japonica* rice to raise the food self-sufficiency rate by creating rice products such as rice noodles and rice bread.

Noodle is one of the most popular rice products in Asia and is mainly produced from *Indica* rice flour since the amylose content of *Indica* is generally much higher than that of *Japonica*, which confers sufficient firmness to noodles. In addition, *Japonica* rice is not appropriate for noodle production because of its stickiness. Furthermore, gelatinized dough of *Japonica* rice with low amylose content is plastic rather than elastic, which lacks firmness that is an important texture when the noodle is masticated in the mouth. Nevertheless development

* Corresponding author.
E-mail addresses: nitta@fhw.oka-pu.ac.jp (Y. Nitta), katsuyoshi.nishinari@gmail.com (K. Nishinari).

https://doi.org/10.1016/j.lwt.2018.07.027
Received 3 March 2018; Received in revised form 14 July 2018; Accepted 14 July 2018
Available online 17 July 2018
0023-6438/

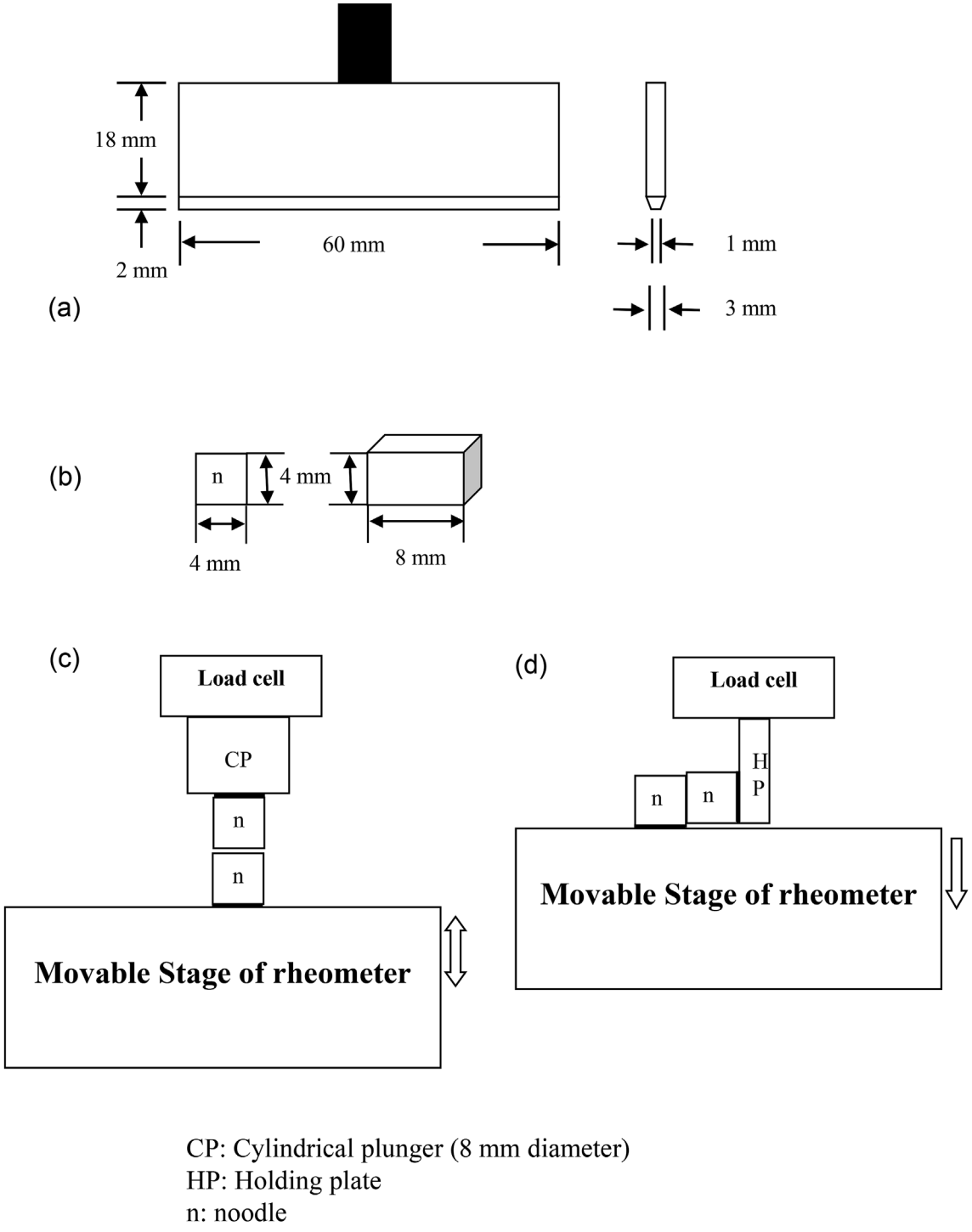

Fig. 1. (a) The shape of an AACC 1 mm flat perspex knife blade (A/LKB-F) Left, front view; right, side view. (b), (c), (d) for each figure: A method to evaluate the adhesiveness (left) and slipperiness from the friction (right) between two noodle strands. Noodles were fixed by the glue to the cylindrical plunger or holding plate and stage of rheometer as shown in thick line.

of *Japonica* rice noodle has been required to respond to the demand of people who like more varieties of staple foods in addition to gluten-free bread which has been made by various methods in many countries. As is well known, rice is not suitable for bread because of the lack of gluten which confers the strength of cell walls in the expanded dough to keep the gas leading to the high specific volume of the baked bread (Nozawa, Ito, & Arai, 2016; Shibata, Sugiyama, Fujita, Tsuta, Yoshimura, Kokawa, & Araki, 2012).

For the noodle production from *Japonica* rice with low amylose content, some additives are expected useful to reduce stickiness and to confer the firmness. Various kinds of polysaccharides have been added to modify the texture of the rice noodle (Kang, Bae, & Lee, 2018; Klinmalai, Hagiwara, Sakiyama, & Ratanasumawong, 2017; Koh, Kasapis, Lim, & Foo, 2009; Sozer, 2009; Wandee et al., 2015). Interaction of alginate, a seaweed polysaccharide, and rice flour has been reported (Chrastil, 1991) and alginate was reported to enhance the structure of rice dough, leading to improvement of noodle texture (Kang et al., 2018; Koh et al., 2009). In their article they did not