Fagopyrum 39 (1): 5-11 (2022)

Research paper

Leaving Buckwheat Noodles after their Making and Subsequent Cooking Leads to Remarkable Changes in Mechanical Characteristics

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DOI https://doi.org/10.3986/fag0023

Received: October 19, 2021; accepted March 19, 2022.
Keywords: common buckwheat, mechanical characteristics, noodles, making, cooking

ABSTRACT

The present study was conducted to analyze the mechanical effects of leaving buckwheat noodles after their fleshly making with or without subsequent cooking. Remarkable reduction with time in breaking characteristics after their freshly making and subsequent cooking were found. The observed decrease in breaking stress and energy showed that the buckwheat noodles might be softened with the leaving time. On the other hand, no brittleness was found in buckwheat noodles from the beginning until leaving time of 1 min, whereas brittleness appeared that after leaving time of 2 min after subsequent cooking. Implications for the observed finding were discussed in view of the palatability of buckwheat products.

INTRODUCTION

Common buckwheat (*Fagopyrum esculentum* Moench) is an important crop in some world areas (Ikeda, 2002; Kreft et al., 2003). Common buckwheat flour is processed into various products such as noodles, pasta etc. There is a large variety of common buckwheat products globally. In view of their processing, increasing attention has been currently paid to the palatability and acceptability of various buckwheat products. Clarifying the scientific basis involved in the palatability and acceptability of common buckwheat products is a subject of great interest. Mechanical characteristics may be an important factor responsible for the palatability and acceptability of common buckwheat products. We have presented some observations relating to mechanical characteristics of common buckwheat products, i.e., relationships between components of buckwheat and its mechanical characteristics (Ikeda et al., 1997); mechanical comparison among doughs of various cereals including buckwheat (Asami et al., 2006); mechanical effects of various binders to buckwheat dough (Ikeda *et al*., 2005; Asami et al., 2019); scientific basis responsible for traditional processing techniques for buckwheat noodles (Asami et al., 2008; Asami et al., 2009; Asami et al., 2010; Asami et al., 2012; Asami et al., 2016; Asami et al., 2018).

In Japan, buckwheat noodles are a popular, traditional food. There are various traditional proverbial sayings about the palatability and acceptability of buckwheat noodles. In such proverbial phrases, buckwheat noodles prepared with all parts of the following four conditions are believed to be more palatable and acceptable: firstly, noodles made from just-harvested and dried buckwheat seed; secondly, noodles made from just-ground buckwheat flour; thirdly, just-prepared buckwheat noodles; and lastly, just-boiled buckwheat noodles. In Japan it has been believed that buckwheat noodles made with all of the above four conditions may be the most palatable. However, the scientific reason responsible for the above common proverbial saying on buckwheat noodles remains largely uncertain. We have shown mechanical changes during buckwheat grain storage (Asami and Ikeda, 2005). In view of clarifying the above traditional proverbial saying, especially in focusing on mechanical changes in buckwheat noodles after just-making and after just-boiling, the present study has been conducted to analyze the mechanical characteristics of buckwheat noodles after their making with or without subsequent cooking.

MATERIALS AND METHODS

Materials

Common buckwheat (*Fagopyrum esculentum* Moench var. Kita-wase-soba), which was harvested in Hokkaido, was used in this study. Commercial buckwheat flours were obtained from Taniguchi-soba Milling Co. (Kyoto, Japan) and stored at -80 °C until used.

Preparation of buckwheat noodles

Buckwheat noodles were prepared according to the procedure described previously (Ikeda and Asami, 2000). Stated briefly, an appropriate amount of buckwheat flour was put in a mixing bowl. Distilled water was added little by little by hand to buckwheat flour with a final flour-to-water ratio of 2:1. The buckwheat flour-water dough was well kneaded by hand in the mixing bowl and then rolled into balls. The well-kneaded balls ware spread by hand and then subjected to a pasta-making machine (Industria Prodotti Stampati, Italy) to prepare buckwheat noodles. The buckwheat noodles were leaving at 4 °C and 27 °C after preparation. Changes in mechanical characteristics were measured daily and hourly. The daily change experiment at 27 °C was not measured because noodles would spoil.

Mechanical measurements

Breaking measurements of buckwheat noodles with a thickness of approximately 1.5 mm, a width of about 4.5 mm and an appropriate length were performed with a Rheoner RE3305 (Yamaden Co. Ltd., Tokyo, Japan). Measurement with a Rheoner RE3305 were performed with a load cell of 2kgf in a measurement speed of 0.50 mm/sec. A wedge style plunger (No.49: W 13mm, D 30mm, H 25mm) was used in the measurements with a Rheoner RE3305. Mechanical measurements of buckwheat noodles were repeated three to six times with those samples.

Protein determination

For chemical analysis of the combined fractions of buckwheat albumin plus globulin in the cooked noodle samples which had been subjected to the mechanical measurements, the noodle samples were lyophilized and then ground into flour. The flours obtained were extracted with a ten-fold (v/w) volume of 0.2M NaCl for 1hr at 4 °C. After extraction, the suspensions were centrifuged at 17,000 g for 20 min. The protein concentration was determined using the Buiret method with bovine serum albumin as the standard protein.

Statistical analysis

Statistical analysis was conducted using a personal computer with the program Excel (Microsoft Co., USA), Ekuseru-Toukei (Social Survey Research Information Co., Japan).

RESULTS AND DISCUSSION

Changes in mechanical characteristics of buckwheat noodles after their making with or without subsequent cooking

Figure 1 shows analytical results on mechanical effects of leaving buckwheat noodles after freshly making and subsequent cooking; Fig. 1 presents the mechanical load as the vertical axis versus mechanical strain as the horizontal axis. The square signs with cross mark in the Fig. 1 show the appearance of brittleness. Figure 2 shows the analytical results as a function of time based on the observed mechanical results of Fig. 1. Remarkable reduction with time in breaking characteristics after their freshly making and subsequent cooking were found (Fig. 2-(A) and (B)). The observed remarkable reduction in breaking stress and energy showed that the buckwheat noodles might be softened with the leaving time.

On the other hand, no brittleness was found in buckwheat noodles from the beginning to a leaving time of 1 min, whereas brittleness appeared after a leaving time of 2 min after cooking (Fig. 2-(C).). In general, it is known that no or low brittleness expresses low breaking energy on masticating foods. The previous studies (Asami et al., 2011) suggest that the appearance of the brittleness of buckwheat noodles may lead to unpalatability. The present finding agrees with our previous findings (Asami et al., 2011). In short, lowering breaking stress and energy

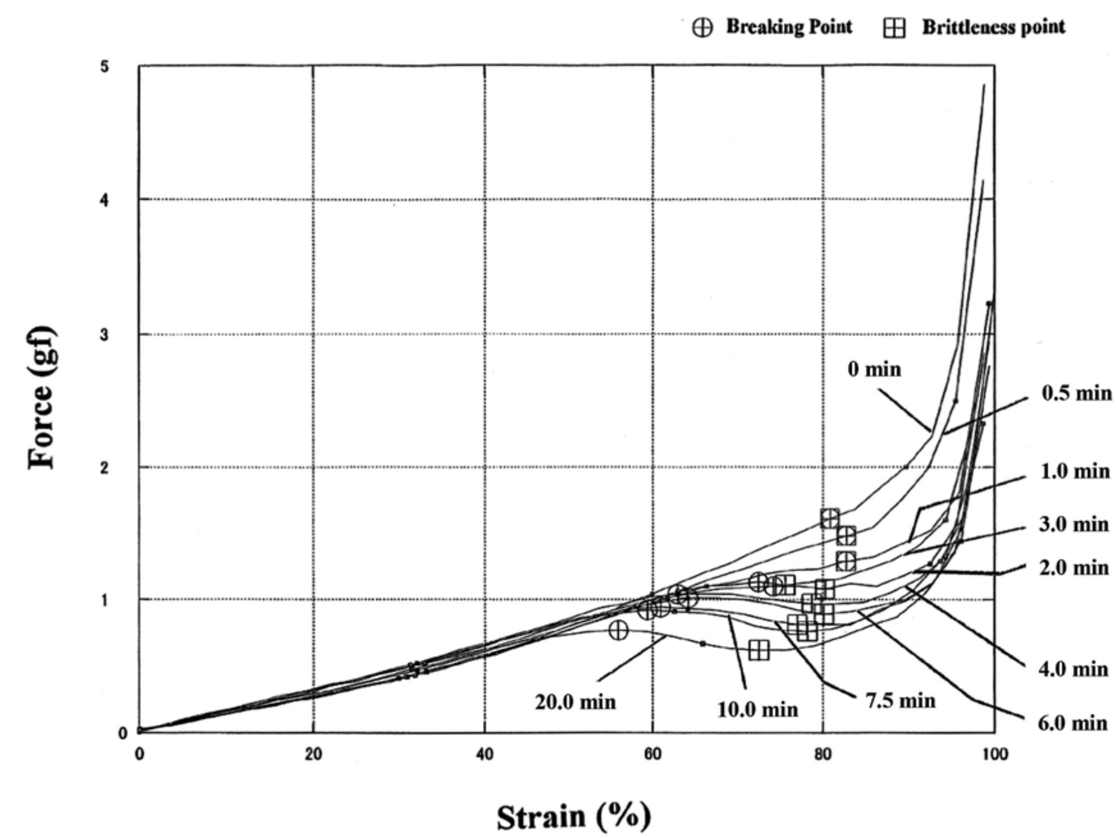

Fig. 1. *Load-to-strain ratio plot curves on the breaking analysis of buckwheat noodles after their boiling.*

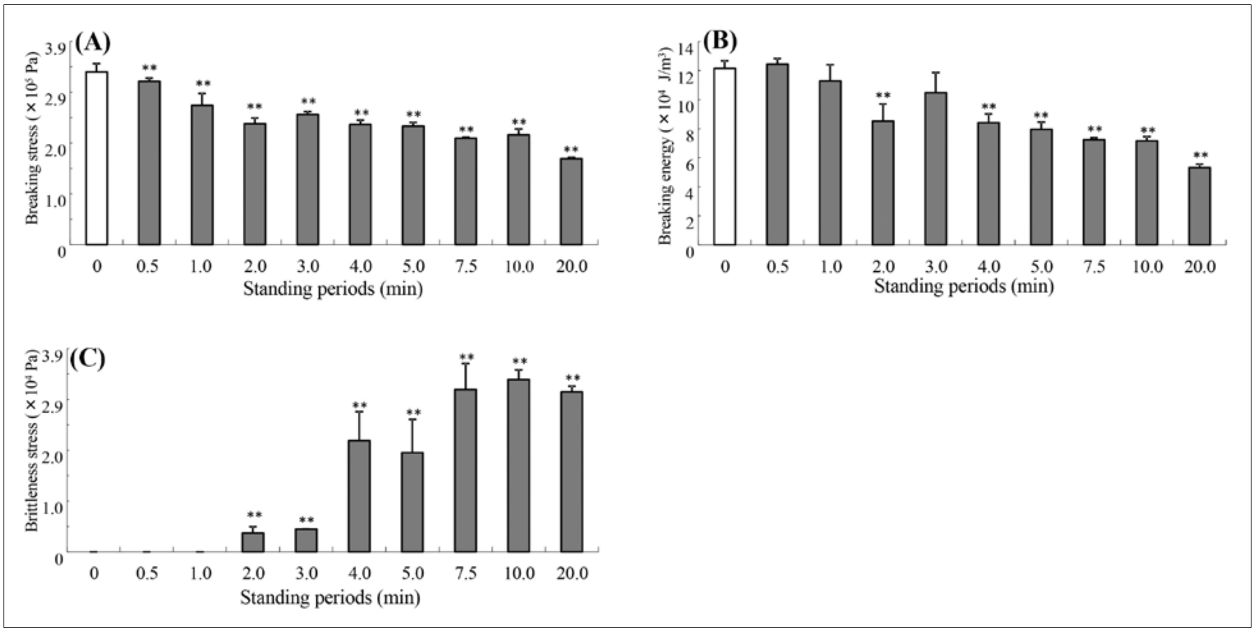

*Fig. 2. Changes in the breaking and brittleness characteristics of buckwheat noodles after their boiling. (A), breaking stress; (B), breaking energy; and (C), brittleness stress. Vertical bars in the figure show the standard deviations. Significant difference from 0 min: **p<0.001.*

and appearance of brittleness may become slowly unpalatable.

In this connection, there is a traditional proverbial indicating that buckwheat noodles just-cooking may be much palatable compared to long leaved buckwheat noodles. Our findings will give the scientific basis involved in such a traditional proverb.

Another experiment was conducted to clarify how leaving buckwheat noodles after freshly making without cooking may affect mechanical characteristics of the noodles. Figures 3 and 4 showed changes in the breaking characteristics of leaving buckwheat noodles after freshly making without cooking. In this case, after leaving, immediately prior to mechanical analysis, buckwheat samples were cooked and then subjected to analysis. Figures 3 and 4 show changes in the breaking characteristics on leaving at constant temperature buckwheat noodles after their freshly making without

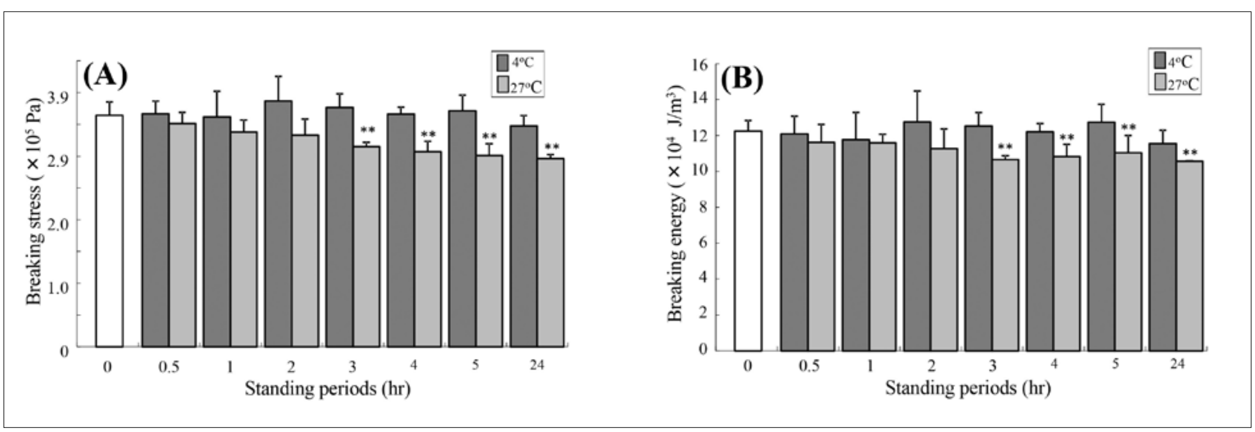

*Fig. 3. Hour-interval-changes in the breaking characteristics of buckwheat noodles after their preparing. (A), breaking stress; and (B), breaking energy. Vertical bars in the figure show the standard deviations. Significant difference from 0 hr: **p<0.001.*

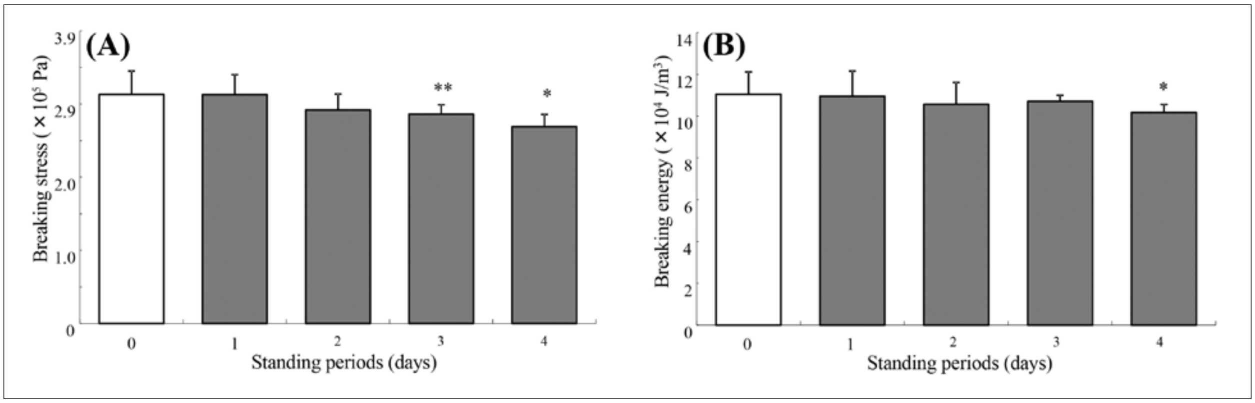

Fig. 4. *Daily changes in the breaking characteristics of buckwheat noodles after their preparing. (A), breaking stress; and (B), breaking energy. Vertical bars in the figure show the standard deviations. Significant difference from 0 day: *p<0.05, **p<0.001.*

cooking: Figure 3 shows hourly changes on leaving at 4 °C and 27 °C of buckwheat noodles produced; and Figure 4, their daily changes at 4 °C. A gradual decrease in the breaking stress (Fig. 3-(A)) and energy (Fig.4-(B)) of buckwheat noodles was found at 27 °C (Fig. 3), whereas less or substantially no changes in the breaking stress (Fig. 3-(A)) and energy (Fig. 3-(B)) of buckwheat noodles were found at 4 °C (Fig. 3). The breaking stress and breaking energy of buckwheat noodles daily decreased at 4 °C gradually (Fig. 4.). A significant (P<0.05) decrease in the breaking stress and energy, as compared with noodles made, was found only after 3 and 4 days. in fact, no or slight changes in mechanical changes were found with buckwheat noodles after freshly making without subsequent cooking. The present findings (Figs. 3 and 4) showed that a gradual, small decrease

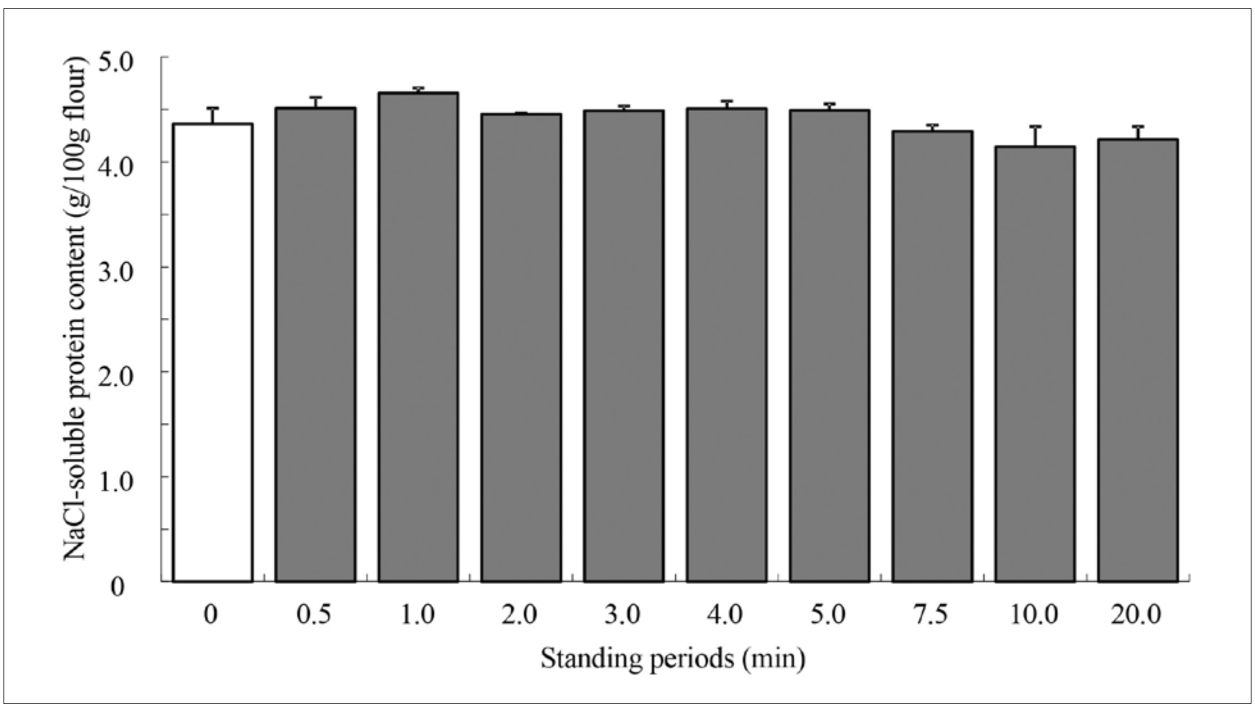

Fig. 5. *Changes in NaCl-soluble protein contents of buckwheat noodles after their boiling. Vertical bars in the figure show the standard deviations.*

in buckwheat noodles' breaking stress and energy occurred after their making without subsequent cooking. These findings show that endogenous enzymes such as proteases and amylases, if any, might not largely involve the mechanical characteristics of buckwheat noodles.

Our present analysis showed drastic changes in buckwheat noodles' mechanical characteristics after leaving and subsequent cooking (Figs. 1. and 2.). In contrast, there were very small changes in mechanical characteristics of buckwheat noodles after freshly making without subsequent cooking (Figs. 3. and 4.).

It remains unclear what factors were responsible for the observed drastic changes in the mechanical characteristics of buckwheat noodles after cooking (Fig. 2.). May be alterations in the chemical form of endogenous protein and starch by cooking are involved. Figure 5 shows changes in the NaCl-soluble protein of buckwheat noodles after their making and subsequent cooking. NaCl-soluble protein expressed the major protein fractions of buckwheat flour, i.e., the combined fraction of albumin and globulin. There were slight changes in the NaCl-soluble protein of buckwheat noodles after boiling (Fig. 5). Our analysis showed a relationship between the observed breaking energy of the buckwheat noodles (Fig. 2 (B)) and the NaCl-soluble protein content (Fig. 5) with $r = 0.636$ ($P<0.05$). This low correlation suggests that there may be other factors, such as starch and dietary fiber, in addition to NaCl-soluble protein, responsible for the observed mechanical changes after making and subsequent cooking (Fig. 2). Further analysis concerning this topic will be an interesting subject in the future.

Finally, the present study shows that remarked mechanical changes in buckwheat noodles occur after their freshly making and subsequent cooking.

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IZVLEČEK

Počivanje ajdovih rezancev po izdelavi in naknadno kuhanje povzročata velike spremembe nekaterih mehanskih lastnosti

Na Japonskem so ajdovi rezanci priljubljena tradicionalna hrana. Obstajajo različni ustaljeni pogledi na zagotavljanje okusnosti in sprejemljivosti ajdovih rezancev. Na splošno na Japonskem velja, da so ajdovi rezanci, ki so pripravljeni iz pravkar pridelanega in posušenega ajdovega zrnja; iz pravkar zmlete ajdove moke; pravkar pripravljeni ter pravkar kuhani najbolj okusni in sprejemljivi. Vendar znanstvene raziskave o vplivu posameznih od navedenih dejavnikov še potekajo. Že predhodno je bilo dokazano, da že med skladiščenjem ajdovih zrn nastajajo vzroki za kasnejše mehanske spremembe testenin (Asami in Ikeda, 2005). V tej raziskavi se avtorji osredotočajo na mehanske spremembe lastnosti svežih ajdovih rezancev takoj po izdelavi in takoj po kuhanju. Namen raziskave je bil analiza nekaterih mehanskih lastnosti ajdovih rezancev glede na počivanje izdelanih rezancev, po kuhanju ali brez kuhanja. Ugotovljeno je bilo, da se tekom časa počivanja zmanjšajo lastnosti prelamlanja. Avtorji prispevka so ugotovili, da postanejo po počivanju rezanci mehkejši. Nasprotno, lomljivost se je pojavila po počivanju testa za 2 minuti in zaporednem kuhanju. Avtorji so razložili pomen teh ugotovitev glede na okusnost ajdovih testenin.