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Quality and antioxidant properties of instant noodles enhanced with common buckwheat flour

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ABSTRACT

The objective of this study was to investigate the feasibility of incorporating common buckwheat (*Fagopyrum esculentum* Moench) into instant noodle formulations. Australian Soft (AS) and Baker's flours were used to evaluate the effects of varying buckwheat contents (0–40%) on noodle quality. The results of texture analysis indicate that noodles made using AS flour produced softer texture whereas there was minimal effect for Baker's flour when buckwheat was incorporated. The colour, measured by L^* values, decreased with increased addition of buckwheat for both flours. Fat uptake for noodle samples made from AS flour was only marginally affected, but increased for Baker's flour, when higher levels of buckwheat flour were added. The antioxidant rutin was detected in noodles made from both wheat flours, generally increasing with % buckwheat flour added. These findings indicate that the incorporation of 20% buckwheat into the formulation can be used to enhance the quality of instant noodles.

1. Introduction

The pseudocereal, common buckwheat (*Fagopyrum esculentum* Moench), is a member of the Polygonaceae. The crop originated in China and is now widely cultivated for its value as a food ingredient. Buckwheat proteins are known for their well-balanced amino acid content (Ikeda and Asami, 2000) and are particularly rich in essential types (e.g., lysine and arginine). In addition, buckwheat proteins have high globulin and albumin contents, and are low in glutelin and prolamin (Pomeranz and Robbins, 1972). Based on chemical and immunological studies, buckwheat protein is a valuable dietary component for gluten sensitive individuals including those with coeliac disease.

Several flavonoids have been identified in buckwheat, i.e. rutin, quercetin, quercitin, kaempferol, orientin/isoorientin, and vitexin/isovitexin (Cai et al., 2004). The flavonoids from buckwheat were found to be effective in reducing blood cholesterol levels, keeping capillaries and arteries strong and flexible, improving blood microcirculation as well as protecting blood vessels from rupturing or forming clots (Cai et al., 2004; Griffith et al., 1994). These flavonoids also demonstrated antioxidant, antimicrobial and anti-inflammatory activities (Cai et al., 2004).

Of these flavonoids, rutin (vitamin P) is the major and most important flavonoid component in buckwheat, and is not found in the cereal grains (Holasova et al., 2002; Oomah and Mazza, 1996). Different cultivars of buckwheat may have varying contents of rutin (Ohsawa and Tsutsumi, 1995). According to Lin et al. (2009), buckwheat enriched food can provide beneficial health effects while preventing oxidation during processing. This is due to the natural antioxidant properties of rutin which may inhibit lipid peroxidation within the food.

With these therapeutic and functional benefits, a variety of food incorporating buckwheat have been produced and are widely consumed in China, Japan, Korea and Bhutan. For example, in Japan, soba noodles made with buckwheat flour are popular (Ikeda and Asami, 2000). Other products in which buckwheat has been blended with grains include multigrain pasta, bread, pancakes and cereal flakes, and research has been carried out to determine its suitability for use in such products.

Past studies found that spaghetti containing dark buckwheat and amaranth had significantly lower firmness values compared with that made with durum flour only (Rayas-Duarte et al., 1996). In a later study, Chillo et al. (2008) demonstrated that spaghetti colour changed with the addition of buckwheat flour, while the spaghetti cooking properties (cooking loss and cooking resistance) were

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similar to those of control samples. In another study, Lin et al. (2009) found that white bread enhanced with buckwheat was rated higher for flavour and mouth feel. The enhanced product also contained more rutin and quercetin which increased antioxidant activity.

Research on food production methods indicates that rutin retention is affected by the activity of the rutin degrading enzyme, flavonol 3-glucosidase as well as certain processing parameters (Kreft et al., 2006). Rutin degrading enzyme has been found in common buckwheat grain, particularly in the testa (Suzuki et al., 2002). Kreft et al. (2006) reported that hydrothermal treatment of buckwheat grain during the production of groats reduced rutin content. Their research indicated that rutin may have been degraded or combined with some other molecules, rendering it insoluble in the solvent used for analysis.

We have recently reported upon the addition of various ingredients (including microbial transglutaminase, emulsifier, water, acetylated potato starch and gum) into instant noodle formulations (Choy et al., 2010, 2012). It was found that the additional ingredients had a major impact on the textural and physical attributes of instant noodles particularly those made from lower protein wheat flour. However, there appear to have been no published studies on the addition of buckwheat into the formulations for this increasingly popular food. Accordingly, this study investigated the suitability of incorporating buckwheat flour into instant noodles. The eating quality (textural, colour and cooking attributes) and the presence of key antioxidant components were investigated to determine the influence of buckwheat in instant noodles.

2. Materials and methods

2.1. Materials

Three types of flours were used in this study, i) Australian Soft, AS (Allied Mills, Melbourne, Australia), ii) Baker's (Weston Milling, Melbourne, Australia) and iii) common buckwheat, *F. esculentum* Moench (Kialla Pure Foods, Greenmount, Australia). The proximate composition of the flour samples was analysed according to AACC International (2000) Approved Methods 44-15A, 08-01 and 46-30 for the determination of moisture, ash and crude protein respectively. Starch damage (%) of flour was determined using an enzymatic digestion assay kit (Megazyme International, Wicklow, Ireland). Rutin trihydrate, quercetin dihydrate standards, acetonitrile and trifluoroacetic acid were purchased from Sigma Aldrich (Sigma Chemical Co., NY, USA). Ethanol and hexane (petroleum spirits) were obtained from Merck KGaA (Merck, Darmstadt, Germany) and Ajax Chemicals (Ajax Chemicals, NSW, Australia) respectively. All chemicals used in product formulations and analytical procedures were of analytical grade or of the highest purity available.

2.2. Instant noodle preparation

Instant noodle dough was formulated by mixing various proportions from 60 to 100% wheat flour (AS or Baker's) with 40–0% common buckwheat flour, then using this flour to combine with 1% salt (NaCl), 0.2% alkaline salt (potassium and sodium carbonate mixed 6:4) and 35% distilled water (all values expressed with respect to the total flour representing 100%). Wheat flour was mixed with common buckwheat flour in a Kenwood mixer (model KM210, Havant, United Kingdom) for 1 min at a speed 1 prior to use. The salt and alkaline salt were dissolved completely with water before use. The water containing dissolved salts was incorporated with the flour (250 g) over a period of 30 s at speed 1. The mixer was then operated for 1 min (at speed 1) and 4 min (at speed 4) until the dough became crumbly. After 1 and 3 min, mixing was discontinued briefly to allow incorporation of small dough pieces adhering to the sides of the mixing bowl. The crumbly dough was then placed into a resealable plastic bag and allowed to rest at room temperature (~22 °C) for 30 min. The dough was then kneaded to form a dough ball and passed through the roll unit of a pasta machine (Imperia MOD 150, Ambrogio di Torino, Italy) with the regulating knob set at position no.1 (2.5 mm gap). The resultant sheet was folded in half and passed through the rolls. Typically, three passes were required in order to give a uniform sheet which held together as a single dough piece. The thickness of the sheet was reduced stepwise by passing between the rolls of the pasta machine, gradually reducing the thickness to 1.5 mm. The sheet was then cut using the cutter attachment and the strands produced were 1.5 mm in width and 1.5 mm in thickness.

The noodles were placed uniformly into a steam pan before placing in a preheated (100 °C) steamer, and steamed for 2 min to allow starch to swell and gelatinize. The final step was frying in hydrogenated palm oil (Jasper International Pty Ltd., Melbourne, Australia). The steamed noodle strands were loosely placed in a wire basket and the basket was immersed in the preheated oil (150 °C) for 45 s. The hydrogenated palm oil was replaced after three cycles of frying. The fried strands were allowed to cool at room temperature (~22 °C) and excess oil was drained from the surface. The cooled samples were then placed into resealable plastic bags for storage and subsequent analysis.

2.3. Cooking of noodles

Fried instant noodle strands (30 g) were added to 1 L of boiling water and cooked for the optimum cooking time using the procedure described by Oh et al. (1983). After cooking, the noodles were cooled in running tap water (~17 °C) for 1 min. The drained noodles were then stored in a covered plastic container at room temperature (~22 °C) for 10 min before texture profile analysis (TPA).

2.4. Evaluation of noodle cooking quality

Textural properties of instant noodles were measured using a TA-XT2 Texture Analyser (Stable Micro Systems, London, United Kingdom). Samples were tested 10 min after cooking (AACC International, 2000; Oh et al., 1983). Measurements were carried out at room temperature (~22 °C) and fresh subsamples were used for each measurement. Calibration settings used were the 5 kg load cell with a return trigger path at 15 mm. The measurement mode settings for compression (pre-test, test and post-test) were set to a speed of 2.0 mm/s; strain was at 75%; trigger type at auto-10 g and a 35 mm cylinder probe was used (Stable Micro Systems, 2000). From force–time curves of the TPA, the hardness (height of the peak) and adhesiveness (negative area between the first and second peak) were determined. Cohesiveness was indicated by the ratio between the area under the second peak and the area under the first peak. Hardness, adhesiveness and cohesiveness values were determined according to the description of Park et al. (2003). Stickiness was determined by measuring the negative area below the second peak.

In order to determine rehydration rate, the fried instant noodle strands (15 g) were cooked to optimum cooking time (until the white core disappeared). The cooked strands were then placed in cold water, drained, wiped with paper towels and retained in covered plastic containers. The gain in noodle weight (after cooking) was recorded as rehydration rate, %.

Cooking loss was measured according to AACC International (2000) and Chakraborty et al. (2003) with slight modification. Cooking water was evaporated to dryness in an oven at 110 °C. After drying, the residue was weighed and solid loss during cooking was expressed as a percentage.