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SHORT COMMUNICATION

Effect of additives and steaming on quality of air dried noodles

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Abstract Texture is the most important property for consumer acceptance in cooked noodles. The air dried noodles are known to have higher cooking loss and cooking time, to that of instant fried noodles. But the fat content of instant fried noodles is more. In the present work attempts were made to optimize the moisture content so as to obtain a smooth dough for extruded noodle preparation and develop air dried noodles of low fat content with lesser cooking loss and cooking time. To meet the objectives, the effect of various additives and steaming treatment on cooking quality, sensory attributes, textural properties and microstructure of noodles were studied. Dough prepared by addition of 40 ml water to 100 g flour resulted into formation of a soft dough, leading to production of noodles of improved surface smoothness and maximum yield. The use of additives (5 g oil, 0.2 g guar gum, 2 g gluten and 1 ml of 1 % kansui solution for 100 g of flour) and steaming treatment showed significant effect on noodles quality, with respect to cooking characteristics, sensory attributes and textural properties. The microstructure images justified the positive correlation between the effects of ingredients with steaming and quality parameters of noodles. Air dried noodles with reduced cooking loss (~50 % reduction) with marginal reduction in cooking time was developed, which were having similar characteristics to that of instant fried noodles. Compared to the instant fried noodle, the prepared air dried noodle was having substantially reduced fat content (~70 % reduction). Thus the present study will be useful for guiding extrusion processes for production of air dried noodles having less cooking time and low fat content.

Keywords Additives · Steaming · Texture · Microstructure · Air dried noodles

Introduction

Noodle is a staple food in many parts of Asia and becoming popular around the world because of its convenience, less time for preparation and desirable-taste properties. Noodles prepared from wheat may be divided into two general classes based on the ingredients used, one is white salted noodles (WSN) made from flour, sodium chloride and water, and another is yellow alkaline noodles (YAN) made from flour, sodium chloride, alkaline salt (such as sodium and potassium carbonate) and water (Asenstorfer et al. 2006). Textural properties are the most critical characteristics when evaluating quality and consumers acceptance of cooked noodles (Hung-Chia et al. 2011). The structural and textural properties of noodles are influenced by several factors, the most important being the properties of the raw material, dough and the drying conditions (Zweifel et al. 2003). Ingredients such as starch, water and protein, and additives like gum play important roles in defining the rheological properties of dough which can be used as quality indicators for the final product (Ong et al. 2010).

Water is an essential ingredient in noodle making. When it is added to the noodle flour and mixed, the gluten network is formed, which contribute to the structure of noodles. Addition of water contributes to the visco-elastic properties of the dough and increase the smoothness of the noodle surface. The addition of salt at 2–3 % in Asian noodles is known to enhance the texture of noodles by strengthening and tightening the structure of gluten to increase visco-elasticity (Hou 2001). Lipids are components that play an important role in most of the extrusion processes. They can act as plasticizers or emulsifiers, and affect more significantly texture and

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stickiness of the extrudate (Ilo et al. 2000). Guar gum is reported to increases dough yield, greater resiliency and improves texture of baked goods (Hou 2001). Kansui is an alkaline salt used for processing of instant noodles to improve color and texture properties. Steaming is a key process in the manufacture of instant noodles. A high degree of starch gelatinization is required for the production of instant noodles. Steaming time is longer for hot-air dried noodles than for deep-fried noodles. Steam induces gelatinization of starch prior to drying which improves the water uptake capacity of noodles (Zhao and Seib 2005; Fua 2008; Yalcin and Basman 2008).

Drying can be done by hot air drying (air dried noodles) or frying (instant fried noodles). The cooking time of instant fried noodles is less compared to air dried noodles and contain higher amount of fat which is a health concern. The present work attempts to optimize the moisture content to obtain smooth dough for extruded noodle preparation and develop air dried noodles of low fat content with lesser cooking time. The effect of various additives and steaming treatment on cooking quality, sensory attributes, textural properties and microstructure of noodles were also extensively studied.

Materials and methods

Materials

Refined wheat flour of HD-2189 variety, procured from local market of Kolhapur city was used to prepare the noodles. The additives used were of food grade.

Dough preparation with varied moisture content

Dough samples (M_1, M_2, M_3, and M_4) were prepared by addition of water (30 ml, 35 ml, 40 ml and 45 ml) in 100 g of flour (Fua 2008). Firstly, 2 g salt was dissolved in water. Then the water was poured on flour and was mixed little to damp each flour particle and to obtain lumps. The lumps were kneaded to obtain dough which was rested for 40 min. Different weighed samples were extruded manually to obtain noodles. The quality, yield and nature of dough as well as extruded noodle were observed visually.

Dough extensibility study of noodles

The dough of different combinations as given in Table 1, were prepared. For preparation of 1 % Kansui solution, 0.2 g sodium carbonate, 0.3 g potassium carbonate and 0.5 g sodium chloride were dissolved in 100 ml water (Ito et al. 2007). The prepared dough samples were rested for 40 min at room temperature, covered with damped muslin cloth to overcome the problem of surface drying. After resting, noodles strands of 2 mm diameter were prepared using single screw extruder (Atlas Regina, Noodle making machine, OMC Macrota SRL, Campodarsego, Italy). The strands were cut in 5 cm pieces and were evaluated for extensibility using TA-XT2 Texture Analyzer, Stable Micro System Ltd., London. A/KIE (Kieffer Extensibility Rig) probe was selected. The analysis was carried out in tension mode at pretest speed 2.00 mm/s, test speed 2.00 mm/s, post test speed 10.00 mm/s. Target mode was kept at distance mode (10.00 mm) and trigger force 5.0 g. Data acquisition rate was kept at 200.00pps. The results were reported as tensile force (g) and breaking distance (mm). Three tests for each sample were carried out to obtain the mean value.

Preparation of dried noodles

The extruded noodles, prepared by using the different formulations, were cut to lengths of 5 cm and dried in tray drier in two stages. In first stage the temperature was kept at 70 °C for 2 h and in second stage 100 °C for 3 h. The formulation of sample H and I were same to that of sample F and G respectively. The noodles were steamed for 10 min on boiling water and dried up to 13 % moisture content.

Table 1 Formulations tried for preparation of air dried noodles

Sample code	Wheat Flour (g)	Water (ml)	Salt (g)	Oil (g)	Guar gum (g)	Gluten (g)	1 % Kansui Solution (ml)	Steaming time (min)
A	100	40	2	–	–	–	–	–
B	100	40	2	1	–	–	–	–
C	100	40	2	5	–	–	–	–
D	100	40	2	5	0.2	–	–	–
E	100	40	2	5	0.5	–	–	–
F	100	40	2	5	0.2	2.0	–	–
G	100	40	2	5	0.2	2.0	1	–
H	100	40	2	5	0.2	2.0	–	10
I	100	40	2	5	0.2	2.0	1	10

Cooking quality evaluation of noodle

The cooking qualities of the dried noodles were evaluated with respect to cooking time, water uptake, cooking loss and thickness after rehydration according to Ritthiruangdej et al. (2011). Optimal cooking time was evaluated by observing the time of disappearance of the core of the noodle strand during cooking (every 20 s) by squeezing the noodles between two transparent glass slides. The water uptake was calculated by getting the difference between weight of cooked noodles and weight of dried noodles. The cooked noodles were placed on filter paper for 5 min before weighing, to blot the excess adhered water. The cooking loss was determined by measuring the amount of solid substance lost to cooking water. A 10 g sample of noodles was placed into 100 ml of boiling water in a 500 ml beaker. Cooking water was collected in a pre-weighed glass dish and was placed in a hot air oven at 105 °C and evaporated to dryness. The dry residue was weighed and reported as a percentage. For each quality parameters three determinations were performed to obtain the mean values.

Sensory evaluation of rehydrated noodles

The cooked noodles were evaluated by a panel of 10 judges for different sensory attributes like surface appeal, hardness, stickiness, bite, mouth feel and overall acceptability. A 5 point (1 to 5) structured scale was used for this evaluation with modifications in sensory description (Desai et al. 2010).

Texture profile analysis (TPA) of rehydrated noodles

The dried noodle samples were cooked for their optimal cooking time and analyzed for texture profile using TA-XT2 Texture Analyzer, Stable Micro System Ltd., London. Texture profile analysis was carried out using probe P/75 (75 mm Compression platen), in compression mode at pretest speed 1.00 mm/s, test speed 5.00 mm/s, post test speed 5.00 mm/s. Target mode was kept at 40.00 % strain and trigger force 5.0 g. Data acquisition rate was kept at 200.00pps. Three tests for each sample were carried out to obtain mean value.

Scanning electron microscopy (SEM) of dried noodles

A scanning electron microscope (JSM – 6360, JEOL, Germany) was applied for the microstructure observation of surface and cross section of dried noodles sample. Among all samples, sample A, C, D, F, G, H and I were selected for microstructure studies, on the basis of results of sensory analysis. Noodle sample of length 5 mm for surface and 2-3 mm for cross section was cut and mounted horizontal and vertical respectively using carbon tape for observation on Aluminum disc of diameter 3 cm and thickness 0.5 cm, coated with carbon tape (NEM Tape). The disc containing specimens was placed in vacuum sublimator sputter coater (JFC – 1600, JEOL, Germany) and sprayed with Platinum. The stub was placed on a pre-cryogenic electron microscope specimen holder that was pre-frozen by liquid nitrogen, and observed at acceleration voltage 10 kV and 20 kV.

Chemical analysis of noodles

The final noodle prepared (sample I) containing 5 g oil, 0.2 g guar gum, 2 g gluten and 1 ml of 1 % kansui solution and steamed for 10 min before drying was compared with reference noodle sample (Instant fried noodle) for the chemical constituents i.e. Moisture, Protein, Fat and Ash content. Total Carbohydrate was calculated by difference. The standard methods described by Ranganna (2000) were used for the determination.

Calories of noodles samples were calculated by multiplying the values of protein, fat and carbohydrate content with 4, 9 and 4 (i.e. kcal per gram) respectively. The basis of selection of reference noodle sample was that it contains high in fat content.

Statistical analysis

Three independent observations of each sample for each test were taken and mean of these observations was used for statistical analysis. The data obtained was subjected to analysis of variance (ANOVA) using complete randomized design. The critical difference at $p < 0.05$ and $p < 0.01$ was estimated.

Results and discussion

Effect of moisture on the physical characteristics of dough and extruded noodle

The results are tabulated in Table 2. The dough prepared by addition of 30 ml water (Sample M_1) was dry and does not form dough. It showed crumb like appearance. At the time of extrusion all the crumbs gathered together near the die and it was hard to rotate the screw and extrude the noodle strands. The noodles were very dry with rough surface and broke immediately. There were non-hydrated flour particles in the noodles. The yield (~75 %) which was less in all samples. The breaking of noodles was attributed to less amount of moisture content, which had affected hydration of starch and gluten.

Addition of 35 ml of water in sample M_2, resulted a dough which was slightly dry in nature. It required less force to extrude the noodles as compared to Sample M_1. The noodles from sample M_2 retained its shape after extrusion and were easy for handling during shifting for drying. This was attributed to good hydration of starch and gluten development. The yield too was observed to increase to 80 %..

Soft dough was obtained after addition of 40 ml water (Sample M_3). The noodles could be extruded with minimum

Table 2 Effect of moisture on the physical characteristics of dough and extruded noodle

Sample Code	Added water (%)	Weight of Dough (g)	Weight of Extruded Noodles (g)	Yield of Noodles (%)	Nature of Dough	Nature of Noodle Strands
M_1	30	128.58^{a}	96.46^{a}	75.019^{b}	Dry and Crumbly	Dry and Rough Surface, Unhydrated flour Particles observed, breaks during handling
M_2	35	133.72^{b}	108.23^{b}	80.937^{a}	Slightly Dry and Hard	Slightly dry and Rough surface, Retains shape
M_3	40	139.06^{c}	128.85^{d}	92.657^{c}	Soft	Smooth surface, Retains shape
M_4	45	144.64^{d}	113.66^{c}	78.581^{a}	Very soft and Sticky	Wet and Smooth surface, Get sticks to each other

The values are the mean of 3 independent observations. The values with different superscripts in a column differ significantly at $p < 0.05$

of efforts and were of improved smoothness of surface. The yield (~90 %) was high among all samples. The noodles retained its shape and were not sticky. The results were attributed to proper hydration of starch and gluten development.

The dough sample M_4 was very soft, wet and sticky in nature. Though it required less force to extrude noodles as compared to other sample, the noodles were very sticky and stuck to each other immediately. The dough was even sticking to the extruder, which resulted in reduced yield (~80 %).

Dough extensibility study of noodles

Dough extensibility analysis of different formulation revealed that the additives have significant effect on tensile force and breaking distance. The results are reported in Table 3. Among all samples, sample F require higher tensile force to extend the dough and gets broken at higher distance. The results attributed to added gluten. These results are in line with Kovacs et al. (2004) who reported that, about 80 % of the total protein of wheat flour is gluten. Gluten proteins are composed of gliadins and glutenins, which are responsible for gluten or dough extensibility (viscosity) and strength (elasticity), respectively. The increase in fat content slightly reduces extensibility of dough. This may due to shortening action of oil in gluten development. The addition of guar gum stabilizes the dough, improves moisture absorption and hence improves extensibility compared to sample C (Hou 2001). Further, alkaline salt solution (Kansui: Sodium carbonate, 0.4 g and potassium carbonate, 0.6 g) contributes to increase the pH thus toughening the dough by strengthening the bonding forces within the starch granules (Hou 2001), which reduces the extensibility and less breaking distance compared to sample F. Beside extensibility, the dough prepared by added gluten (sample F) and Kansui (sample G) shows difference in color of dough. Sample F was slightly darker (grayish brown) and sample G was yellow in color. The color difference in sample is shown in Fig. 2.

Table 3 Extensibility of dough sample prepared from different formulations

Sample code	Tensile Force (g)	Breaking Distance (mm)
A	8.854^{ab}	16.402^{b}
B	8.315^{a}	13.563^{ab}
C	8.160^{a}	11.869^{a}
D	8.504^{ab}	18.492^{bc}
E	8.621^{ab}	18.643^{bc}
F	9.456^{b}	20.351^{c}
G	8.971^{ab}	19.897^{c}

The values are the mean of 3 independent observations. The values with different superscripts in a column differ significantly at $p < 0.05$

Cooking quality evaluation

The results from Table 4, showed that as fat content increased cooking time also increased, but the cooking loss decreased. The reduction in thickness after rehydration was due to reduced water uptake capacity. The added fat content migrated towards surface and restricted the entry of water, and generated improper starch gelatinization. Addition of guar gum reduced cooking time. At the level 0.2 g cooking loss decreased, but at level 0.5 g the cooking loss increased. The increase in thickness is attributed to increase in water uptake capacity. It is reported that the guar gum helps to prevent oil droplets from coalescing; hence the oil was distributed evenly and did not

Table 4 Effect of ingredients and steaming on cooking quality of noodles

Sample code	Cooking time (min)	Cooking loss (%)	Water uptake (g/g)	Thickness after rehydration (mm)
A	6.80^{a}	16.1^{g}	1.26^{NS}	2.8^{NS}
B	7.00^{ab}	13.3^{c}	1.10	2.6
C	7.40^{ab}	12.79^{c}	1.03	2.5
D	7.20^{ab}	10.84^{d}	1.21	2.6
E	6.60^{a}	14.48^{e}	1.35	2.7
F	8.20^{b}	9.62^{b}	1.13	2.7
G	7.60^{ab}	9.16^{b}	1.26	2.8
H	7.00^{ab}	8.32^{a}	1.16	2.4
I	6.40^{a}	8.21^{a}	1.31	2.5

The values are the mean of 3 independent observations. The values with different superscripts in a column differ significantly at level $p < 0.05$ and ^{NS} are not significant

interfere with soaking of water which resulted in greater water holding capacity of guar gum which swelled and resulted in increased thickness of noodles. Addition of gluten powder improved the property which reduced cooking loss. It was observed that if the water uptake capacity was slightly decreased, cooking time increased significantly. The hydration capacity of gluten is reported to increase significantly at slightly alkaline pH. The addition of kansui increased the pH of dough; hence improved the cooking quality of noodles. The reduced cooking loss is due to strengthening the bonding forces within the starch granules. The CO_2 produced developed porosity in dried noodles. This lead to increase in water uptake and hence ultimately reduced cooking time. No significant change in thickness of noodle samples was observed. The steaming before dehydration showed remarkable effect on all cooking quality parameters after rehydration. This was attributed to increase in water uptake of pre-gelatinized starch. The increase in moisture content while steaming made the noodles dry very slowly and become dense which resulted in tough with reduced thickness after rehydration. The gelatinization of starch created strong bonding with other molecules and also reduced the amount of free amylose content, which reduced the cooking loss. The noodles became glossy and compact in nature after steaming.

Sensory evaluation of rehydrated noodles

The results of sensory analysis are given in Fig. 1 and 2. All the test samples were evaluated for sensory attributes by considering the maximum sensory score as 5 for each parameter for the market sample. It was observed that the additives and steaming treatment had significant effect on sensory quality of cooked noodles. Addition of fat at level 5 g reduced stickiness, due to formation of amylose-lipid complex. During cooking fat gets accumulated on surface, leading to improved surface with respect to smoothness and shine. Reduction in water uptake made the noodles hard and gave optimal bite. Further the addition of guar gum (0.2 g) improved the quality with respect to bite. However when 0.5 g of guar gum was used, it reduced the quality with respect to stickiness and mouth feel. The extra guar gum solubilized in cooking water and developed starchy and slimy coating over the surface of noodles, but the surface was smooth. The addition of 2 g gluten to sample D, gave a noodle with improved mouth feel and overall acceptability, and reduced stickiness. Kansui solution improved the quality with respect to surface appeal, hardness, stickiness and overall acceptability. It had no effect on bite and mouth feel. The noodles were of smooth and shiny surface, firm texture and mildly sticky. Sample F and G were taken as reference and steamed for 10 min. The results denoted that steaming improves the quality of sample F with respect to all sensory parameters, except mouth feel. Steaming treatment prior to drying of sample G gave noodles of highest sensory score. Sample I was having very smooth and shiny surface, firm and characteristic texture, non-sticky, with good bite and consistent mouth feel.

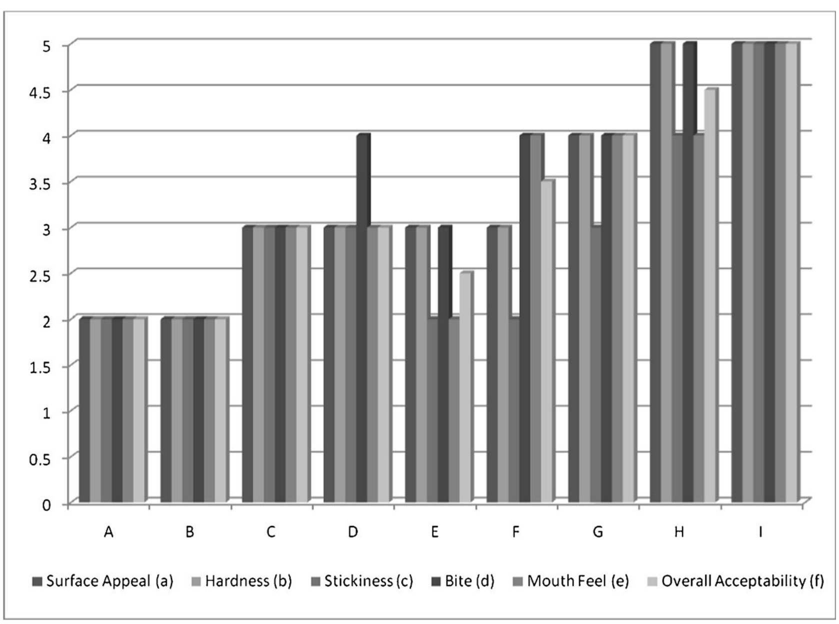

Fig. 1 Effect of ingredients and steaming on sensory quality of noodles. Description of Score: **a** 5 = very smooth and shiny, 4 = smooth and shiny, 3 = slightly smooth and slightly shiny, 2= rough and pasty, 1= very rough and pasty; **b** 5= firm and characteristic, 4= firm, 3= slightly firm, 2= soft and pasty, 1= very soft and pasty; **c** 5=non-sticky, 4 = mildly sticky, 3= moderately sticky, 2= sticky, 1= very sticky; **d** 5= characteristic bite, 4= good bite, 3= optimum bite, 2= less bite,1= not characteristic; **e** 5 = consistent, 4= consistent and little sticky, 3= soft and sticky, 2 = much soft and very sticky, 1 = very soft and very sticky; **f** 5 = Very good, 4= good, 3 = acceptable, 2= poor, 1= very poor

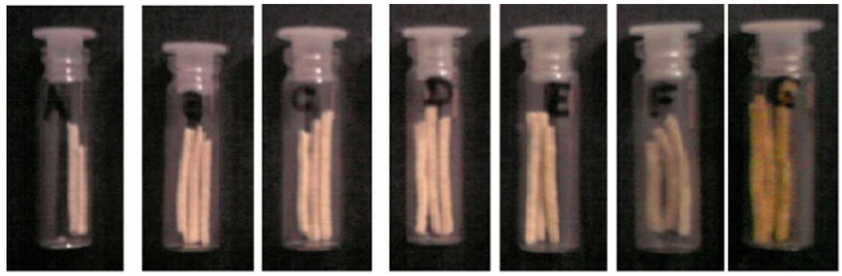

Fig. 2 Effect of additives on color of noodle samples

Texture profile analysis (TPA) of rehydrated noodles

The texture profiles of noodles prepared were affected by the composition and steaming and results obtained are as shown in Table 5. The effect was more significant with respect to hardness and adhesiveness. Among all samples control sample (A) was more sticky and soft. The addition of oil reduced stickiness but increased hardness. The elasticity, resilience and cohesiveness also decreased. Guar gum at level 0.2 g improved noodle quality with respect to all parameters. However, when it was increased to 0.5 g it increased stickiness. Gluten addition showed positive effect with respect to elasticity and resilience, but increased stickiness. Further, addition of kansui solution reduced stickiness with lesser firmer texture. Compared to sample F, the elasticity, resilience and cohesiveness of sample G was less. Steaming improved all quality parameters of noodles. Among all samples, the stickiness was lowest and elasticitys was highest for sample H and I.

Scanning electron microscopy (SEM) of dried noodles

The micro-structural examination of dried noodle samples by SEM (Fig. 3) showed that the added ingredients had significant influence on both surface and internal structure of noodles. At magnification level of 1000×, effect of additives was clearly observed. In the sample A (Image A1 and A2) the free and less compact starch granules were clearly visible on the surface on noodle and not encased within the protein matrix. The protein content was not able to encase the larger size starch molecule. This indicated that the stickiness of noodle sample A was mainly due to over exposing of the starch molecules. The cross section image showed that the internal structure in less compact and molecules are less tightly held to each others, which was responsible for the higher cooking loss of sample A. The SEM of sample C (Image C1 and C2) showed that addition of oil at 5 g gives a noodle of smooth surface compared to sample A. At 1000× magnification level, it was observed that starch granules were less exposed and hence less sticky surface. Also, the internal structure was slightly compact. Addition of guar gum (0.2 g) made the noodles smooth with more uniform surface (Image D1 and D2). The starch molecules were encased more in matrix. The internal structure of sample D was denser as compared to sample C. The guar gum stabilized the structure by making the matrix very cohesive which increased the hardness of noodle. Addition of gluten showed remarkable effect on surface as well as internal structure of noodle sample F (Image F1 and F2). The added gluten was able to encase the starch molecule and increased the compactness resulting in lesser exposure of starch molecules and hence the entry of water. The compact and denser structure leads to increase in hardness. The microstructure of sample G (Image G1 and G2) indicates that the addition of kansui solution increases pH of dough and strengthens the bonding of starch molecules. This will leads to noodle of improved surface,

Table 5 Texture profile analysis of rehydrated noodles

Sample code	Hardness (gf)	Adhesiveness (gf)	Springiness	Resilience	Cohesiveness
A	516.901^{a}	-25.132^{e}	0.863^{a}	0.681^{a}	0.826^{a}
B	532.653^{b}	-19.657^{d}	0.831^{b}	0.651^{b}	0.758^{b}
C	592.168^{c}	-12.180^{b}	0.852^{ab}	0.674^{abc}	0.788^{c}
D	628.458^{d}	-11.650^{b}	0.876^{ac}	0.692^{ac}	0.835^{ad}
E	643.589^{e}	-16.427^{c}	0.883^{c}	0.725^{d}	0.843^{ade}
F	653.281^{ef}	-15.079^{c}	0.981^{d}	0.811^{f}	0.895^{f}
G	663.538^{fg}	-12.826^{b}	0.978^{d}	0.762^{e}	0.869^{fe}
H	671.524^{g}	-7.308^{a}	0.989^{d}	0.813^{fg}	0.896^{f}
I	685.485^{h}	-6.145^{a}	0.986^{d}	0.789^{fg}	0.878^{f}

The values are the mean of 3 independent observations. The values with different superscripts in a column differ significantly at $p < 0.05$ level

gf = gram force

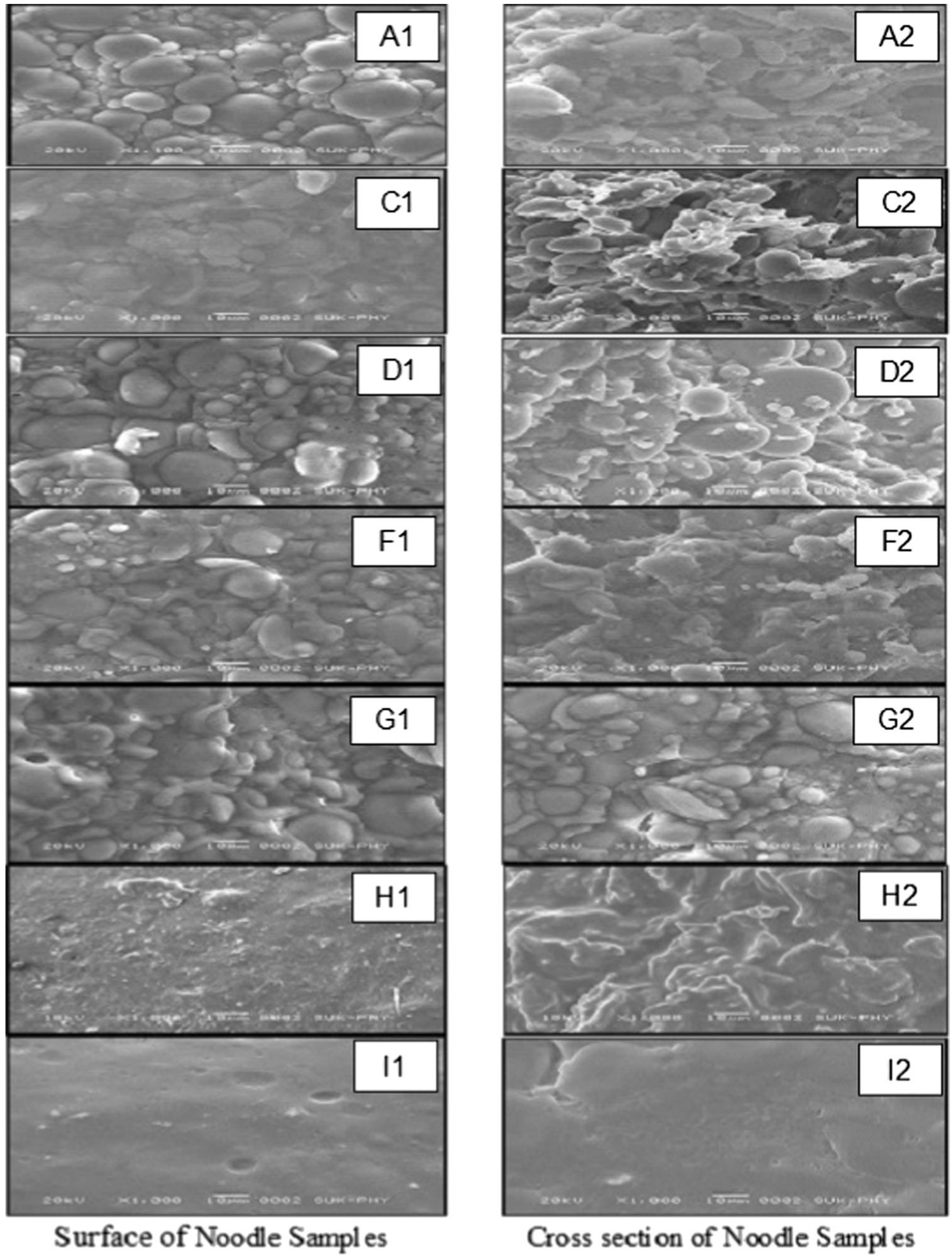

Fig. 3 SEM images of selected noodle samples

reduced stickiness and more compact structure. When such noodles samples were steamed it resulted in noodles of smoother surface (Image H1, H2, I1 and I2). Starch molecules were not observed in SEM image of surface and showed only continuous starch and protein matrix. Steaming of noodles gelatinized the starch molecules and was fully encased by protein. This lead to reduction in cooking time, cooking loss and stickiness.

Chemical analysis of noodles

The results of comparative chemical analysis of final noodle sample (I) and a noodle samples obtained from market, taken as reference is given in Table 6. The results showed that the

Table 6 Chemical composition of noodle having highest sensory score

Parameters	Sample I (Air dried noodle)	Market sample (Instant fried noodle)
Moisture (%)	11.60^{b}	8.22^{a}
Protein (%)	9.76^{a}	9.16^{a}
Fat (%)	5.23^{a}	16.88^{b}
Ash (%)	0.68^{a}	0.74^{a}
Total Carbohydrate (%)	72.73^{b}	65.00^{a}
Calories(kcal)	377.03^{a}	448.56^{b}

The values are the mean of 3 independent observations. The values with different superscripts in a row differ significantly at $p < 0.05$ level

moisture content of market noodle was less due to frying method used for drying of noodle. No significant difference was observed in protein content and ash content of noodles. The major concern of issue was fat content, which was significantly high in market sample. The final sample which was having highest sensory score developed from the present work resulted in ~70 % reduction in fat content compared to the market samples.

Conclusion

It was found from the present study that, addition of 40 ml water for 100 g flour was optimal for preparation of well developed noodle dough resulting in noodles of improved surface smoothness. Addition of additives (5 g oil, 0.2 g guar gum, 2 g gluten and 1 ml of 1 % kansui solution) to 100 g flour had remarkable effect on dough extensibility and noodles quality with respect to cooking, sensory and textural properties. Further treatment of steaming improved quality of noodles with respect to surface appeal. The noodle prepared from the above formulation was having about 50 % reduction in cooking loss with marginal reduction in cooking time compared to the control. The scanning electron microscopy has proven an effective method to study the interactions of ingredients in noodles and justified the effect of ingredients with steaming treatment on the quality parameters of noodles. Finally, instant air dried noodles with substantial reduction in fat content but having similar sensorial quality characteristics to that of instant fried noodles were developed.

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