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Evaluation of Physical and Functional Properties of Multi Millet (Proso, Kodo and Barnyard) Convenience Noodles

M. Naga Sai Srujana, T. Sucharita Devi, B. Anila Kumari, R. Geetha Reddy, S. Triveni

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ABSTRACT

The utilization of multi millet (proso, kodo and barnyard) flour in noodles preparation can be beneficial due to their nutritional composition. Therefore, the current work was focused to prepare high nutrients noodles by incorporating multi millet flour in refined wheat flour at 60, 70, 80, 90 and 100% levels. Among the incorporations 60% multi millet flour incorporated noodles had highest acceptability index and was selected for analysis of physical and functional properties. The multi millet incorporated noodles showed an increase in color a* values from (0.75±0.05 to 2.05±0.50) with a gradual decrease in L* values from (75.32±0.10 to 49.65±0.09) and b* values from (11.52±0.15 to 9.97±0.28). The physical properties of multi millet conveninece noodles was significantly decreased compared to control noodles. Whereas, the functional properties such as bulk density (13.23±0.04 to 18.4±0.06), tapped density, WAI (1.67±0.02 to 2.09±0.04), WSI (131.5±0.1 to 147.5±0.6), OAC (2.19±0.01 to 2.24±0.01) and cooking loss (0.91^{b}±0.03 to 1.41^{a}±0.02) had significantly ($P<0.05$) increased. Whereas, the functional properties like WHC, cooking time and increase in weight after cooking had significantly reduced with addition of multi millet flour.

Keywords Water holding capacity, Oil holding capacity, Water absorption index, Water solubility index, Expansion ratio.

INTRODUCTION

Technology advancement and need for functional foods had made modifications in processing of cereals for maximum benefits. Multi-cereal/ millet or multigrain products are primarily targeted as the vital carriers of the nutrition (Kudake *et al.* 2018).

Noodles were traditionally made from basic materials including wheat flour, salt, vegetable oil, optional additives (gums) and water. Noodle's main

M. Naga Sai Srujana
PhD Scholar, Department of Foods and Nutrition, Post Graduate and Research Center

Dr T. Sucharita Devi*
Professor and University Head, Department of Foods and Nutrition, College of Community Science, PJTS Agricultural University, Saifabad 500001, Hyderabad, Telangana. India.

Dr B. Anila Kumari
Assistant Professor, Department of Foods and Nutrition,

Dr S. Triveni
Professor and Department Head, Department of Agricultural Microbiology and Bioenergy, College of Agriculture.

Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad 500030, Telangana, India

Dr R. Geetha Reddy
Professor and Department Head, Department of Extension Education and Communication Management, College of Community Science, Saifabad, Hyderabad, Telangana, India

Email : sucharithadevi.hyd@gmail.com
*Corresponding author

indispensable ingredient is wheat flour, which provides necessary dough characteristics viz. plasticity, cohesiveness and elasticity (Kumar and Prabhashankar 2015).

The wheat flour noodles available in market are convenient foods are potentially rich in carbohydrates, lack in crucial nutrients like dietary fiber, essential amino acids/ proteins, minerals and vitamins. Hence, there is a requirement to improve the nutritional quality of noodles by enriching with different fortificants which are potentially rich in dietary fiber, proteins and antioxidants to promote health benefits of consumers (Chin *et al.* 2012).

Noodles are being prepared with wheat, rice, buckwheat and starches derived from potato, sweet potato and pulses (Li *et al.* 2012). Acceptance of noodles and the noodle qualities are defined by visual attributes of the uncooked and cooked noodles, they should remain firm and non sticky after cooking. Excellent starch noodles are expected to have transparent threads with high tensile strength and less cooking loss even with prolonged cooking (Purwani *et al.* 2006).

Millets are a group of small seeded species of cereal crops belonging to the family *Gramineae* and widely grown around the world for food and fodder. The most widely cultivated species in order of worldwide production are pearl millet (*Pennisetum glaucum*), foxtail millet (*Setaria italica*), proso millet (*Panicum miliaceum*) and finger millet (*Eleusine coracana*) (Crawford *et al.* 2003).

Millets are considered as crop of food security because of their sustainability in adverse agro-climatic conditions (Ushakumari *et al*. 2004). Along with nutrition millets offer health benefits in daily diet and help in the management of disorders like diabetes mellitus, obesity, hyperlipidemia, cancer (Veena 2003).

Millets have great potential for being utilized in different food systems by virtue of their nutritional quality and economic importance. There is a wide scope of their exploitation in different food products including bakery products, instant mixes and convenience food mixes (Subbulakshmi and Karpagavalli 2017).

Various attempts have been made to supplement wheat flour with flours like oat flour, sweet potato flour, malted ragi flour, rye flour, dehusked barley, buckwheat and single millet to enhance and provide essential nutrients in various products. Noodles are a good option of utilizing the health benefits of millets as it is a food that is convenient and consumed by all the age groups, a better way to supply essential nutrients, and antioxidants. Hence, the present study was conducted with a focus to enhance the nutritional profile of noodles by incorporation of maximum possible level of multi millet flour.

MATERIALS AND METHODS

The present research study was conducted in Post Graduate and Research Center (PGRC), Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar, Telangana District. The study was conducted on "Physical and functional parameters of multi millet convenience noodles". The main ingredients (multi millet flours) used in the development of multi-millet convenience noodles were purchased from millet dealers and distributors and the other ingredients like refined wheat flour, hydrocolloid guar gum was procured from local market. The convenience noodles were developed by using extrusion technology (Nilusha *et al.* 2019).

Procedure for the preparation of multimillet noodles

All ingredients such as refined wheat flour, millets flour (i.e., proso, kodo and barnyard), were weighed as shown in Table 1 using a cold extruder (La Monferrina Pasta making machine, Agaram Industries, Hyderabad). The extruded noodles were dried in tray drier (Thermo control systems, Hyderabad). The dried and cooled multimillet noodles were packed in low density poly ethylene (LDPE) covers. Sensorially MMNF1 formulations of multi millet convenience noodles was selected and used for analysis of physical and functional properties. Physical properties like weight, height, length/breadth ratio, thickness,

Table 1. Formulations of multi millet convenience noodles.

Sample	Proso flour (g)	Kodo flour (g)	Barnyard flour (g)	Refined flour (g)
MMNF1	20	20	20	40
MMNF2	35	17.5	17.5	30
MMNF3	20	40	20	20
MMNF4	22.5	22.5	45	10
MMNF5	33.3	33.3	33.3	-
CN	-	-	-	100

Note: All the formulations were repeated three times.
MMNF1: Proso, kodo and barnyard millet (1:1:1) incorporated noodles.
MMNF2: Proso, kodo and barnyard millet (2:1:1) incorporated noodles.
MMNF3: Proso, kodo and barnyard millet (1:2:1) incorporated noodles.
MMNF4: Proso, kodo and barnyard millet (1:1:2) incorporated noodles.
MMNF5: Proso, kodo and barnyard millet (1:1:1) noodles, CN: Control Noodles.

expansion ratio, color and functional properties like bulk density, tapped density, water holding capacity (WHC), water absorption index (WAI), water solubility index (WSI), cooking time, solid loss, oil absorption capacity and increase in weight were estimated by following the method of (Takhellambam *et al.* 2016).

Statistical analysis **:** Statistical analysis was carried out analyzed to test the significance of the results using percentages, means and standard deviations (Snedecor and Cochran 1983). All the analysis was performed in triplications and the results were presented as mean ± standard deviation. Difference between the variables was tested for significance by (ANOVA) using SAS version 9.1.

RESULTS AND DISCUSSION

Physical properties of multi millet convenience noodles

Multi millet convenience noodles were developed using millet flours (proso millet, kodo millet, barnyard millet) and refined wheat flour in proportions and labeled as (MMNF1-20:20:20:40, MMNF2-35:17.5:17.5:30, MMNF3-20:40:20:20, MMNF4-22.5:22.5:45:10, MMNF5- 33.3:33.3:33.3:0 and CN- 0:0:0:100). Sensorially MMNF1 formulation of the developed multi millet convenience noodles was accepted by 15 semi trained panel members and was selected. The accepted product and the control was powdered and used to analyze the physical properties as given in Table 2.

Weight and height: The weight and height results showed a significant difference between multi millet convenience noodles and control noodles. The weight of the multi millet noodles was (MMNF1-3.5±0.15) low compared to the weight of control noodles was (CN- 3.8±0.20). The height of the multi millet convenience noodles (MMNF1-18.10±0.36)was less compared to control noodles (CN- 20.77±0.26).

Similar results were found by (Vijayakumar *et al.* 2010). height results of the branded noodles (0.20±0.0 cm) was high compared to noodles prepared with standard composite flour, 10% millet flour blend incorporated composite flour (0.14±0.0 cm) and 20% millet flour blend incorporated composite flour (0.13±0.0 cm) due to the less gluten content. Incorporation of 60% multi millet flour had resulted

Table 2. Physical properties of convenience noodles.

Sample	Weight (g)	Height (cm)	Length/breadth ratio (mm)	Thickness (mm)	Expansion ratio (mm)
MMNF1	3.5^{b}±0.15	18.10^{b}±0.36	113.10^{b}±0.3	1.64^{a}±0.05	1.10^{b}±0.01
CN	3.8^{a}±0.20	20.77^{a}±0.26	118.01^{a}±0.2	1.73^{a}±0.08	1.18^{a}±0.01
Mean & SE	3.65±0.17	19.43±0.62	115.55±0.91	1.69±0.04	1.14±0.02
CD	0.54	2.51	1.86	0.60	0.01
CV (%)	1.23	3.68	0.45	2.34	0.35

Note : Values are expressed as mean ± standard deviation for the two determinants. Means within the same column followed by common letter do not significantly differ at P≤ 0.05.
MMNF1: Proso, kodo and barnyard millet (1:1:1) incorporated noodles.
CN: Control noodles.

in (18.10±0.36) which was less, that might be due to low gluten content of millet.

Length/bredth ratio: The results showed that the length/bredth ratio of multi millet noodles (MMNF1-113.10±0.3) was significantly (P<0.05) less compared to the length/bredth ratio of control noodles was (CN- 118.01±0.2).

The results reported by (Vijayakumar *et al.* 2010) showed that height/ width ratio was highest for branded noodles (1.25±0.0) followed by 10% millet flour blend incorporated composite flour (1.17±0.0), standard composite flour (1.148±0.04) and lowest for 20% millet flour blend incorporated composite flour (1.12±0.08).

Thickness and expansion ratio: Expansion ratio and thickness values of the multi millet convenience noodles was significantly (P<0.05) low compared to the control. The thickness of MMNF1 was (1.64±0.05 mm) and that of control noodles was (CN-1.73±0.08 mm). The expansion ratio of MMNF1 was (1.10±0.01) and control was (1.18±0.01).

The thickness results of the dried multi-millet noodles incorporated with sweet potato flour studied by (Mithila *et al.* 2021) for control was (1.59 mm), with different levels of sweet potato incorporation the thickness of the noodles was reduced (i.e. T_1- developed with incorporation of 30% (sorghum, bajra and foxtail) and 5% sweet potato flour had (1.47mm), T_2- 10% sweet potato flour had (1.45mm) and T_3- 15% sweet potato flour had (1.33mm).

The expansion ratio of 20% millet flour incorported composite flour noodles had (0.71±0.07) was significantly less compared to 10% millet incorporated noodles (0.75±0.09), standard composite flour noodles (0.76±0.03) and was highest in branded noodles (1.43±0.0) was reported by (Vijayakumar *et al.* 2010).

Color score of developed convenience products

The color of food ingredients is important as it had a visual appeal on the product. Color measurement of food products had been used as an indirect measure of other quality attributes as it is simple, faster and correlates well with other physico-chemical properties. The L* a* b* units are often used in food research studies to determine the uniform distribution of colors as they are very close to human perception of colour (Sahin *et al.* 2011).

Table 3. Color values of convenience noodles.

Sample	ΔL	Δa	Δb
MMNF1	49.65^b±0.09	2.05^a±0.50	9.97^b±0.28
CN	75.32^a±0.10	0.75^b±0.05	11.52^a±0.15
Mean&SE	62.48±0.09	1.4±0.27	10.74±0.21
CD	0.25	0.35	1.18
CV (%)	0.15	0.15	0.13

Note : Values are expressed as mean ± standard deviation for the two determinants.
Means within the same column followed by common letter do not significantly differ at P≤ 0.05.
MMNF1: Proso, kodo and barnyard millet (1:1:1) incorporated noodles.
CN: Control noodles.

The color scores of convenience noodles was presented as L*, a* and b* values as given in Table 3. L* indicates lightness and extends from 0.0 (black) to 100.0 (white), a* represent redness (+a*value) to greenness (-a*value) and b* indicates yellowness (+b*value) to blueness (-b*value).

The L* and b*values of control noodles (CN-75.32±0.10), (CN- 11.52±0.15) were significantly (P<0.05) high compared to multi millet convenience noodles (MMNF1- 49.65±0.09), (MMNF1-9.97±0.28). In contrast multi millet convenience noodles (MMNF1- 2.05±0.50) had highest a* values compared to control (CN- 0.75±0.05).

Noodles prepared with incorporation of ragi flour (10, 20, 30, and 40% levels) to wheat flour showed that the control noodles illustrated highest L* values which reduced steadily with increasing ragi flour content. The a* value increased while the b* value decreased with increasing incorporation of ragi flour in the wheat flour (Kudake *et al.* 2018). Similar results were found in my study i.e. as percentage incorporation of multi millet increased there is a decrease in L* and b* and increase in a*.

Table 4. Functional properties of multi millet convenience products.

Sample	Bulk density (g/ml)	Tapped density (g/ml)	WAI (%)	WSI (%)	Water holding capacity (g/ml)	Oil absorption (%)	Cooking time (sec)	Cooking loss (%)	Increase in wt (g)
MMNF1	18.4^{a}±0.06	19.71^{a}±0.03	2.09^{a}±0.04	147.5^{a}±0.6	26.15^{a}±0.35	2.24^{a}±0.01	6.14^{b}±0.02	1.41^{a}±0.02	6.85^{b}±0.01
CN	13.23^{b}±0.04	14.43^{b}±0.06	1.67^{b}±0.02	131.5^{b}±0.1	29.13^{b}±0.42	2.19^{a}±0.01	7.14^{a}±0.03	0.91^{b}±0.03	7.62^{a}±0.02
Mean & SE	15.81±1.15	17.07±1.18	1.88±0.09	139.50±3.56	27.63±0.71	2.21±0.01	6.66±2.23	1.16±0.22	7.23±0.01
CD	0.22	0.38	0.16	2.51	0.77	0.08	0.05	0.13	0.15
CV (%)	0.40	0.64	2.49	0.51	0.79	1.11	0.22	2.77	1.25

Note : Values are expressed as mean ± standard deviation for all the two determinants. Means within the same column followed by common letter do not significantly differ at P≤ 0.05.
MMNF1: Proso, kodo and barnyard millet (1:1:1) incorporated noodles, CN: Control noodles.

Functional properties of multi millet convenience noodles (MMNF1)

The accepted multi millet convenience noodles (MMNF1) compared to control noodles (CN) was given in Table 4 .

Bulk density and tapped density: The bulk and tapped density showed a significant (P<0.05) difference between the sample and the control. The bulk density and tapped density of multi millet convenience noodles was (18.4±0.06), (19.71±0.03) less compared to the bulk density and tapped density of the control noodles was (13.23±0.04), (14.43±0.06).

Water absorption index (WAI) and water solubility index WSI: Water absorption index (WAI) of multi millet convenience noodles (2.09±0.04) was significantly (P<0.05) high compared to the control (1.67±0.02) and the water solubility index (WSI- 147.5±0.6) was significantly (P<0.05) high compared to the control noodles.

The water absorption (%) of the multi millet noodles prepared with (5% incorporation of sweet potato flour, 30% millet flour and 60% refined four) had 92.81% and 10% of sweet potato noodles had 88.61%, 15% sweet potato flour had 78.48%, control noodles prepared with refined flour had 98.53% was reported by (Mithila *et al*. 2021).

Water holding capacity (WHC) and oil absorption capacity (OAC): The WHC of multi millet convenience noodles (26.15±0.35) was significantly (P<0.05) low compared to control (29.13±0.42). Whereas, there is no significant difference (P<0.05) between the OAC values of multi millet convenience noodles (2.24±0.01) compared to control noodles (2.19±0.01).

Cooking time and cooking loss: The results of cooking time and loss had significant (P<0.05) difference. Cooking time was high for control (7.14±0.03) compared to multi millet noodles (6.14±0.02). Where as, the cooking loss was high in multi millet noodles(1.41±0.02) compared to control noodles (0.91±0.03).

The cooking loss was significantly higher in 50% and 100% finger millet noodles compared to rice noodles. Addition of hydrocolloids significantly reduced cooking losses due to gum network formation around starch granules which encapsulate during cooking and restricting the excessive swelling and diffusion of amylose content was reported by (Dissanayake and Jayawardena 2017).

Increasing in weight: There was a significant (P<0.05) decrease in the weight after cooking of multi millet convenience noodles (MMNF1) by 10.1% when compared to control noodles.

The cooked weight of the optimized noodles developed with (Sorghum flour- 24.61%, Soy flour- 13.23%, Gluten- 2.95%) had (17.30 ± 0.17) and that of refined wheat flour noodles had (18.87 ± 0.55) was reported by (Rani *et al.* 2018).

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