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To evaluate the nutritional qualities of a pasta made with foxtail millet and chickpea

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Abstract
The goal of this study was to create pasta using foxtail millet flour and chickpea flour by including 30, 40, 50, and 60% foxtail millet flour and 10% chickpea flour in whole flour. The physiochemical, cooking quality, texture profile analysis, colour analysis, and organoleptic acceptability of the generated pasta were all evaluated. In comparison to ordinary pasta, its proximate composition revealed the simplest amounts of proteins and minerals, as well as a significant amount of fat. Variation 4 pasta cooking time was found to be significantly longer (8.4 to 8.8 min) than control pasta (8.0 minutes), with V2 pasta cooking time being the best and V4 pasta cooking time being the worst. The hardness value is prepared pasta was found to be low in V4, and it was statistically significant ($p<0.05$) compared to the other pasta samples. The sensory evaluation found that the organoleptic features of the various variations differed significantly. Pasta made with 50% foxtail millet in whole wheat grain was shown to be more acceptable than pasta made with other percentages of foxtail millet. Pasta has a universal demand and is an appropriate carrier for nourishing a segment of the population that is health aware. The addition of rapidly increasing quantities of nutrient-rich foods over a long distance improves the health of the vast majority of health-conscious people.

Keywords: foxtail millet, chickpea, proximate, cooking, textural characteristics, organoleptic

Introduction
Due to various changes in the economic landscape, urbanization increased women's employment, and greater per capita income, demand for ready-to-eat foods such as extruded items has surged. Pasta is often heavy in starch but lacking in dietary fibre, minerals, vitamins, phenolic compounds, and other nutrients. More nutritious pasta products rich in minerals, phenolic compounds, and dietary fibre with a low glycemic index have become the subject of paramount significance as the health-conscious population has become more concerned.
Foxtail millet (*Setaria italica (L.)* is one of the minor millets with a high protein (12.3 percent) and mineral (3.3 percent) content (Vithal, and Machewad, 2006) [1]. It has the highest chromium concentration of all millets (0.03mg per 100g). Foxtail millet has a high dietary fibre content, which is an important nutraceutical component that helps to regulate a variety of illnesses such as diverticulitis, colon cancer, glucose metabolism, insulin response, obesity, stroke, and cholesterol levels (Reddy *et al*., 2010) [4]. Chickpeas (*Cicer arietinum* L.), commonly known as garbanzo beans, are an old-world pulse (i.e., edible seeds) in the legume family (USDH, 2016) and have traditionally been incorporated into many culinary creations because of their nut-like flavor and versatile sensory applications in food (Deosthale, 1982) [3]. People choose foods that are ready to eat and ready to cook, are simple to prepare, take less time to prepare, and are healthful and nutritionally dense. Because of demographic shifts, increased purchasing power, women working outside the home, and affluence, modern consumers seek ready-to-eat and ready-to-cook products.
Pasta is a traditional cuisine that is popular among consumers because of its convenience in terms of transportation, handling, cooking, and storage. Pasta is important not only because of its high consumer demand but also because of its nutritional value. Pasta is nutritive because of its low glycemic index and non-cholesterol and low-fat content (Silva *et al*., 2013) [6], as well as its low glycemic index effect (Brennan *et al*., 2004) [5]. Fibres added to pasta formulations can help close the gap between fibre requirements and existing intakes, resulting in a commonly consumed functional staple meal with nutritional value and reasonably high fibre content. Because of the uncertainty about how these fibre types and amounts added to foods alter and possibly deteriorate pasta formulation, dietary fibre applications in pasta products have remained in the research phase, while some successful cases have been commercialized, still facing challenges of limited consumer acceptability. The effectiveness of foxtail millet and chickpea addition on pasta proximate, colour, textural, and sensory qualities was researched to find novel nutritionally perspective pasta by replacing wholegrain wheat flour.

Materials and Methods
Raw materials for the study
The raw materials chosen for this study, like foxtail millet (*Setaria italica*), chickpea (*Cicer arietinum*), and wheat were bought from the local market of Salem, Tamil Nadu. All the purchased materials were cleaned and

freed from crumpled stones, dirt, and other extraneous materials. Then the materials were cleaned properly and powdered well into fine flour for further procedure.

Formulation of pasta
The flour levels of mixing ingredients at various ratios (foxtail millet: chickpea: wheat) were incorporated into the formulation of pasta: 100 percent wheat flour as control, 30:10:60 (V1), 40:10:50 (V2), 50:10:40 (V3) and 60:10:30 (V4). While making pasta, all of the flours (100g) were mixed for 10 minutes in the mixing chamber of the pasta extruder with the ideal amount of water with 2% salt to evenly distribute water throughout the flour particles. The moist flour aggregate was placed in the pasta machine's metal extruder attachment (Model: Dolly La Monferrina, Italy) fitted with an adjustable die, then cut. After the preparation of pasta, the drying of pasta was administered using a food-grade dryer at 60°C for about 3 hours.

Proximate analysis of foxtail millet and chickpea pasta
Using the AACC method (2000) the proximate characteristics like moisture, protein, fat, energy, and ash contents of pasta samples were determined. Carbohydrate was studied by deducting the sum of moisture, fat, protein, and ash from 100.

Texture profile analysis of foxtail millet and chickpea pasta
For dry pasta samples, hardness and strength parameter was assessed using a breakthrough probe with a single cycle compression test. The measurement mode settings for double-cycle compression (pre-test, test, and post-test) were set to a speed of 1.0 mm/sec; trigger type at auto-10 g; and data rate: 200pps. The hardness, stringiness, and adhesiveness parameters of cooked pasta were evaluated by a Texture Profile Analysis (TPA) with a TVT 6700 Texture analyzer (Perten Instruments, Sweden). A 35 mm diameter cylindrical probe (made of aluminum) was used to compress single pasta at a constant deformation rate of 1 mm/s to 80% of the thickness. The measurement mode settings for double-cycle compression (pre-test, test, and post-test) were set to a speed of 1.0 mm/sec; trigger type at auto-10 g; and data rate: 200pps.

Color profile of foxtail millet and chickpea pasta
Color was determined using a Lovibond® LC Tinto-meter with model LC100 & SV100 Kit, which measured instrumental parameters using the CIE lab system, where colour space is a Cartesian coordinate system defined by three rectangular coordinates L* (brightness or clarity) from white (L = 100) to black (L = 0), a* (red-green), b* (yellow-blue) of dimensionless magnitudes. The colour of pasta was studied in cooked pasta until the optimal cooking time was reached, following which it was allowed to rest for 5 minutes until it reached room temperature. Three measurements were taken, each with its average.

Organoleptic acceptability of foxtail millet and chickpea pasta
The sensory quality refers to the several senses associated with food preparation and consumption. A semi-trained panel of ten judges evaluated all of the generated pasta for acceptability. A panel of 10 judges evaluated products for sensory quality based on appearance, colour, flavour, taste, texture, and general acceptability using a 9-point Hedonic scale with values ranging from 1 to 1, where 1 = dislike strongly, 5 = neither like nor dislike, and 9 = like extremely. The samples were coded and presented to the panelists in random order.

Statistical analysis
All experiments in the present analysis were conducted in triplicate, and mean values were reported. The collected data were analyzed using to Analysis of Variance (ANOVA), and the means were compared using Duncan’s Multiple Range Test at 0.05 significance.

Results and Discussion
Proximate analysis of foxtail millet and chickpea pasta

Table 1: Proximate analysis of foxtail millet and chickpea pasta

Proximate analysis	Standard	V1	V2	V3	V4
Energy (kcal)	345.9±1.79^{a}	347.7±1.89^{b}	348.7±2.14^{a}	349.7±1.82^{a}	350.7±2.04^{a}
Protein (g)	10.07±0.74^{b}	12.67±0.24^{ac}	12.58±1.01^{b}	12.49±0.45^{b}	12.4±0.51^{b}
Fat (g)	2.84±0.64^{a}	2.82±0.54^{ac}	3.05±0.25^{c}	3.28±0.21^{bc}	3.51±0.32^{a}
Zinc (mg)	1.7±0.43^{a}	1.63±0.33^{bc}	1.39±0.85^{bc}	1.18±0.52^{ac}	0.99±0.37^{ac}
Calcium (mg)	43.6±0.54^{bc}	43.8±0.34^{b}	42.1±0.64^{ac}	40.4±0.63^{b}	38.7±0.41^{b}
Phosphorus (mg)	243.5±2.41^{a}	238.2±2.41^{de}	202.7±1.57^{de}	167.2±2.45^{ac}	131.7±2.14^{bc}
Vitamin A (mcg)	5.48±0.85^{a}	11.05±0.95^{ac}	10.33±0.96^{b}	9.6±0.31^{bc}	8.88±0.36^{bc}
Iron (mg)	3.63±0.75^{a}	3.37±0.35^{ab}	3.1±0.21^{bc}	2.87±0.55^{ac}	2.64±0.8^{ac}

Values are the means ± standard errors of means (SEM) of 3 determinants. Means with the same superscript are not significantly different using Duncan’s Multiple Range Test ($P < 0.05$).

The proximate composition of pasta made from foxtail millet and chickpea flour indicates that compared with the standard the variations have a considerable amount of nutrients shown in table -1. The highest energy content was found in V4 followed by V3, V2, and V1. Regarding protein content, the highest protein was found in V1 followed by V2 and the lowest was found in V4. The energy content was significantly differing at ($p<0.05$) in V1 than the other variations compared with the standard. Similar findings have been reported by Slathia *et al.* (2016) [7] in noodles supplemented with germinated mung bean flour. The fat content was ranged from 2.82 to 3.51g, in this highest fat was found in V1 which may be due to the water absorption of the flours. All the formulated variations showed some significant differences between the samples at a 0.01% level. Low-fat content implies that it would have fewer challenges of rancidity during storage. Results on Duncan's Multiple Range test showed that there was a significant difference between all the developed pasta samples using foxtail millet and chickpea flour.

Textural profile analysis of foxtail millet and chickpea pasta

Table 2: Textural profile analysis of foxtail millet and chickpea pasta

Pasta variations	Dry pasta		Cooked pasta		
	Hardness (N)	**Strength (N/mm)**	**Hardness (N)**	**Stringiness (mm)**	**Adhesiveness (J)**
Standard	12.745±2.43	6.37±1.22	13.65±0.46^{a}	6.69±0.23^{a}	2.03±0.23^{a}
V1	6.00±0.74^{a}	3.00±0.37^{a}	11.76±3.23^{ab}	6.94±0.15^{a}	1.45±0.423^{c}
V2	9.006±1.93^{a}	4.503±0.97^{bc}	9.94±1.04^{ac}	6.907±0.14^{d}	1.40±0.617^{ac}
V3	15.07±3.12^{b}	7.53±1.56^{a}	8.54±0.917^{ac}	6.96±0.04^{e}	0.910±0.018^{b}
V4	14.75±3.06^{a}	7.37±1.53^{b}	9.48±1.79^{b}	6.78±0.14^{c}	1.09±0.099^{b}

Values are the means ± standard errors of means (SEM) of four (3) determinants. Means with the same superscript are not significantly different using Duncan's Multiple Range Test ($P < 0.05$).

The hardness values of dry pasta made from wheat flour, foxtail millet, and chickpea flour ranged from 6.00N to 14.75N. As the amount of foxtail millet flour increased, dry pasta hardness values increased for V3 and V4 but decreased for V1. In the V3 pasta formulation, the hardness value was reached high with a value of 15.07N, and it was statistically significant than other pasta samples ($p < 0.05$). The strength of the pasta was differing significantly between V2 and V4. During pasta processing, gluten proteins present as irregular globular structures that build a three-dimensional network when the flour is mixed with water. After kneading, gluten is often considered to be a network composed of layers of light-coated films, which may only be pierced by the starch granules.

The hardness values of cooked pasta made from wheat flour, foxtail millet, and chickpea flour ranged from 8.54N to 11.76N. Compare with standard, the developed pasta sample variations showed the lowest hardness. As the amount of foxtail millet flour increased, cooked pasta hardness values slightly lowered compared with V1. In pasta prepared from 30% foxtail millet flour, 10% chickpea flour, and 60% wheat flour, the hardness value was reached the highest in V1, and it was significantly higher than those of other pasta samples ($P < 0.05$). The stringiness of cooked pasta samples ranged from 6.78mm to 6.96mm. The highest stringiness was found in 50% incorporation of foxtail millet in V3 (6.96mm). There was a significant difference between the stringiness of the pasta samples in all developed variations. The adhesiveness values of cooked pasta made from wheat flour, foxtail millet, and chickpea flour were ranged from 0.91J to 1.45J and for V1 the highest adhesiveness was found to higher with the value of 1.45J. As the amount of foxtail millet addition increased, adhesiveness was altered for V1 and V2 but for V3 and V4 there was no significant change has occurred. Results on Duncan's Multiple Range test showed that there was a significant difference between all the pasta samples developed using foxtail millet and chickpea flour.

Colour analysis of foxtail millet and chickpea pasta

Table 3: Colour analysis of foxtail millet and chickpea pasta

Variations	Dry pasta			Cooked pasta		
	L*	**a***	**b***	**L***	**a***	**b***
Standard	70.3±0.24^{b}	4.4±1.40^{a}	15.6±0.87^{a}	56.5±0.41^{a}	2.4±0.27^{b}	11.3±0.84^{a}
V1	74.8±1.20^{ac}	3.8±0.97^{b}	18.3±0.41^{b}	56.8±0.88^{ac}	1.9±0.44^{c}	11.7±0.57^{bc}
V2	71.7±2.12^{ab}	3.7±0.82^{d}	17.7±0.85^{ac}	56.5±0.77^{ab}	1.8±0.74^{a}	11.6±0.61^{d}
V3	72.7±0.97^{a}	3.5±0.75^{ac}	17.8±0.94^{a}	55.2±0.73^{d}	1.7±0.26^{b}	11.2±0.81^{b}
V4	71.5±0.75^{d}	3.1±1.04^{b}	17.9±0.72^{ab}	55.1±0.65^{c}	1.9±0.22^{ac}	11.8±0.74^{a}

Values are the means ± standard errors of means (SEM) of four (3) determinants. Means with the same superscript are not significantly different using Duncan's Multiple Range Test ($P < 0.05$).

In considering the results of the dry pasta color coordinates (Table -3), it was found that the lightness intensity of pasta (L*) changed in the range from 71.5 to 74.8. Generally, slightly higher values of L* intensity were obtained in V1 pasta made of standard wheat flour along with foxtail millet and chickpea flour. Redness (*a**) color of pasta included a range from 3.1 to 3.8. V4 pasta (foxtail millet and chickpea flour) was characterized by lower values of a* than the pasta produced from wheat. A similar kind of color intensity was found while examining the value of pasta yellowness (*b**), where the values changed in the range from 17.7 to 18.3.

Cooked pasta showed a significant difference ($p>0.05$) in the luminosity parameter, while there was a statistically significant difference ($p<0.05$) in chromaticity parameters of cooked pasta. The higher concentration of foxtail millet and chickpea flour incorporation in pasta showed slight alteration in the L, a*, and b* attributes, respectively. This kind of monotonous occurred due to the higher concentration of fiber, pigments, and other structural components that are naturally present on external corn layers, as pierced out by Kaminski *et al.* (2011) [10] in pasta incorporated with wholemeal rye flour. In accordance with other researchers who have seen a decrease in yellowness of pasta containing chickpea, green pea, yellow pea, lentil, and quinoa flours (Wood, 2009; Petitot *et al*., 2010a) [8, 9].

Organoleptic evaluation of foxtail millet and chickpea pasta

Table 4: Organoleptic evaluation of foxtail millet and chickpea pasta

Variations	Appearance	Colour	Flavour	Texture	Taste	Overall acceptability
Standard	8.20 ± 0.78^{d}	8.00 ± 0.94^{a}	7.60 ± 0.84^{a}	8.10 ± 0.73^{a}	7.70 ± 0.94^{a}	8.00 ± 0.81^{bc}
V1	7.70 ± 0.94^{a}	7.90 ± 0.73^{ab}	7.40 ± 0.96^{abc}	7.30 ± 0.94^{ab}	7.80 ± 0.91^{a}	7.70 ± 0.94^{ab}
V2	7.60 ± 0.84^{a}	7.70 ± 0.67^{ab}	7.80 ± 0.91^{abc}	8.00 ± 0.94^{abc}	8.10 ± 0.56^{a}	8.20 ± 0.63^{abc}
V3	7.70 ± 0.82^{a}	7.90 ± 0.73^{ab}	7.80 ± 0.91^{abc}	8.40 ± 0.69^{c}	8.30 ± 0.67^{a}	8.40 ± 0.69^{abc}
V4	8.00 ± 0.81^{a}	7.90 ± 0.73^{ab}	8.20 ± 0.78^{bc}	8.10 ± 1.19^{abc}	8.10 ± 0.73^{a}	8.60 ± 0.51^{c}

Values are the means ± standard errors of means (SEM) of 3 determinants. Means with same superscript are not significantly different using Duncan's Multiple Range Test ($P < 0.05$).

The organoleptic evaluation of the pasta revealed that there have been significant differences among the variations for the sensory qualities. The quality was judged by the consumer panel team consisting of fifteen members. Overall acceptability of pasta ranged from 7.70 to 8.60. The V4 was mostly accepted by all sensory panels (overall acceptability 8.60) whereas, the V1 was the subsequent lowest overall score by the sensory panel (overall acceptability 7.70). This result's almost like Yadav *et al*. (2011) [11] who reported that the sensory properties of biscuits prepared by replacing refined flour up to 20% which each with plantain and chickpea flour were more or less almost like those of control biscuits. Sensory evaluation moreover, constitutes the first reference against which the results obtained by chemical or instrumental methods should be compared to accept, check, or improve any method. Results on Duncan's Multiple Range test showed that there was a significant difference ($p<0.05$) between all the pasta samples developed using foxtail millet and chickpea flour.

Conclusion

The current research shows that chickpea flour and foxtail millet can be used to modify the colour of pasta and improve its nutritional quality. Different quantities of foxtail millet and chickpea flour were used to make the pasta. The results showed that increasing the foxtail millet concentration enhanced the fibre content, reduced the cooking time, and improved the softness of the pasta more than the control sample. Pasta with 50% foxtail millet incorporation in wheat grain was judged to be the most acceptable, followed by pasta with 30%, 40%, and 60% foxtail millet incorporation. The pasta made using legume-based flours had acceptable weight gain and cooking losses during the cooking process. The addition of chosen legume flour to whole wheat flour pasta may improve the intensity of the pasta's color and consumer acceptance.

Acknowledgment

Nil

Conflict of interest

No conflict of interest

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