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Studies on effect of pretreatment on cooking quality of foxtail millet products

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Abstract
Foxtail Millet is considered as underutilized cereal and its potential is not fully exploited as energy dense nutritious food that can help in malnutrition and preventing and curing lifestyle diseases such as diabetes, cardiovascular diseases, and obesity. To explore its full potential as a regular ready to cook breakfast food, foxtail millet was pre-treated with treatments like roasting (T2), soaking and tray drying (T3) and soaking and roasting (T4) before processing them into semolina and flour. The raw foxtail millet was considered as Treatment (T1). The semolina is extracted in Hammer mill and analyzed for the physical properties like bulk density, swelling power and Solubility Index, Emulsion activity (%) and emulsion stability (%), Foam capacity (%) and foam stability. The semolina sample (T3) was promising in terms of physical properties. The ready to cook breakfast such as Idli and Dosa prepared from foxtail millet and black gram in 70:30 ratio. The rice based Idli and Dosa kept as control to assess the nutritional and sensory attributes. There is an increase in the nutritional values of the samples compared to the control sample with the exception of the carbohydrate content and the replacement of rice with the foxtail millet decreased the carbohydrate content and increased the protein, fat, fiber and total ash content in both Idli and dosa. Moisture content was maximum decreased in roasted grains (61.61%) than soaking and tray drying (63.17). protein content was high in raw foxtail millet (16.11) as compared to control samples (12.26), pre-treatment significantly decreased protein content maximum reduction was observed in soaking and tray drying sample(14.28). Fat content was high in T1 sample (3.49) and minimum reduction was observed in roasted sample (3.38). Pre-treatment significantly increases crude fibre content maximum increased in soaking +roasted sample (13.96) followed by roasted sample (13.61). The sample 'T3' has better acceptance in terms of sensory attributes as compared to other samples.

Keywords: foxtail millet, pre-treatment, physical properties, nutritional analysis, sensory evaluation

Introduction
Millets are minor cereals and form the staple food for a large segment of the population, mainly those with low socio-economic status, in India and Africa (Singh R. *et al*., 2004). The resilience exhibited by them may prove good for their adjustment to different eco-systems and make them potential crops for contingency plantings (Verma V and Patel S., 2013). They are an important source of vital minerals like niacin, magnesium, phosphorus, manganese, iron and potassium. They contain high amounts of protein, fiber, essential amino acid methionine, lecithin, and vitamin E (Shobana Devi R and Nazni, 2016). Recent studies have shown that due to the high content of these nutrients, millets have therapeutic benefits such as control of asthma, migraine, blood pressure, diabetes, heart disease, atherosclerosis and heart attack. Fibre, in millet, prevents gallstones formation. Because of these benefits, millets can be used in functional foods and as nutraceuticals. Hence, they are also called as 'nutri cereals' (Stanly J M and Shanmugam A., 2013). Foxtail millet *(Setaria italica)* ranks second in the total world production of millets. It is one of the easily cultivated cereal grains belonging to the *Setaria* genus of *Poaceae* family and subfamily *Panicoideae*. Foxtail millet contains 9–14% protein, 70–80% carbohydrates and is a rich source of dietary fiber (Hadimani and Malleshi, 1993). It contains maximum amount of chromium among all the millets with an account of 0.030 mg per 100 g. (Deshpande and Poshadri, 2011) [4] Polymers of hexose's, pentoses, cellulose and pectinacious material constitute the major portion of its dietary fiber (Malleshi, 1986). Foxtail millet, like most millets, is also a good source of crude fiber, helps in the digestive process and helps to induce bowl movement, thus producing a laxative effect that is beneficial for a healthy digestive system (Krishna, 2013).

Mamatha Rani *et al*., (2019) [12] prepared steam cooked Instant millets puttu mix from combination of finger millets with foxtail millets (50:50) were found to be better acceptability in organoleptic property and nutritional quality. Instant puttu mix stored in low density polyethylene and aluminium standing pouch for three months at ambient temperature (27±5°C). The chemical composition of finger millet and foxtail millet instant puttu mix comprise average value of crude protein 12.18 per cent, crude fiber 9.15 per cent, calcium 200.68 mg/100g, iron 6.24 mg/100g, magnesium 170.54 mg/100g, phosphorus 294.25 mg/100g.

Jaybhaye and Srivastav (2015) [7] were developed a ready-to-eat (RTE) puffed and toasted snack food product from Barnyard millet and Toasting experiments were designed using central composite rotatable design (CCRD) at varying temperature (84 – 126°C) and time (10 – 30 min). There was significant reduction in moisture content, colour and hardness of toasted product with increase in toasting temperature and time whereas there was higher increase in crispness at lower levels but less increase at higher levels of toasting parameters. The quality attributes like moisture content, colour, crispness and hardness of the optimally toasted snack food were 0.046 kg kg-1 dm, 69.79, 18.45 and 362.64 g, respectively at the optimum temperature and time combination of 116.26 oC and 20.23 min, respectively. The

total energy content of the BM snack food was 380.74 kcal per 100 g product. Pandey *et al.*, (2017) were made an attempt to develop foxtail millet based value added vermicelli. Standardization trials indicated that acceptable foxtail millet vermicelli could be developed by substituting 50 per cent processed foxtail millet flour in the standard vermicelli recipe. In order to improve functional properties of vermicelli further different trials were carried out by replacing wheat semolina with black gram dhal flour. Black gram dal flour was incorporated at 5, 10, 15 and 20 per cent levels by substituting wheat semolina while level of foxtail millet flour was kept constant at 50 percent. Among all the trials, vermicelli with 20 percent black gram dhal flour was found to be highly acceptable. Cooking, textural and sensory properties of formulated vermicelli were observed and compared with the control. Thus, the study presented an upshot of potentials of foxtail millet as a natural designer health food for patients suffering with life style diseases.

Materials and methods

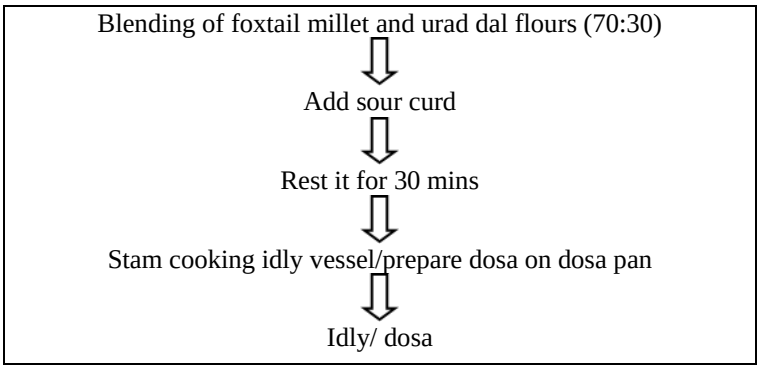
Commercially available decorticated foxtail millet grains were procured in bulk from local market, Warangal and stored in sealed containers and used throughout the research work.

Pre-treatments

Table 1: Pretreatments given to millet grains

S.no	Pre-treatments	Methodology
1	Raw	Raw foxtail millet grains were taken and grinded into fine powder and coarse powder
2	Roasting	Foxtail millet grains were roasted at 180ºC for 2 mins and grinded into powders
3	Soaking + tray drying	Foxtail millet grains were soaked with water in 1:2 ratio for up to 6 hours and the grains were completely dried in tray drier until the moisture content reduced to 12% and grinded into powders
4	Soaking+ roasting	Foxtail millet grains were soaked with water in 1:2 ratio for up to 6 hours and the grains were roasted at 180ºC until flavour developed and grinded into powders

Methodology



Flow sheet 1: Process flow sheet of foxtail millet products

Results and discussion

Nutient composition of pre-treated foxtail millet grains

Proximate composition of idly sample

The samples were grounded into fine powder, defatted and packed in zip lock pouches and stored in a dessicator and used for analysis of proximate composition. The moisture, protein, fat and ash contents were analysed by following standard AOAC methods (AOAC, 2005) and were expressed in g/100g.

Moisture content

The moisture content of the foxtail millet based idly significantly decreases during pre-treatment. But rice based idly had high content of moisture (66.23) compared to foxtail millet based idly (65.61). Low moisture content was observed in roasted sample (61.61).

Carbohydrate content

High carbohydrate content was observed in rice based idly (72.44). Pre-treatment significantly increases the carbohydrate content. High content of carbohydrate was observed in soaking and tray drying sample (63.76).

Protein

High content of protein was observed in foxtail millet based idly (16.11%) than in rice based idly (12.26%) Because foxtail millet had high content of protein compared to rice. By applying different pre-treatment protein content was slightly decreases. Maximum reduction was observed in soaking + roasted sample (14.28%).

Fat content

Pretreatment significantly decreases the fat content it may be due to oxidation and degradation of fat during processing. Maximum reduction was observed in soaking+roasted sample (2.40). High content of fat was observed in foxtail millet based idly (3.49) compared to rice based idly (0.83).

Crude fibre

Crude fibre content of raw foxtail millet based idly was 11.01%. Pretreatment significantly increases the crude fibre content. High content of crude fibre was observed in soaking+roasted sample (13.96)

Total ash

There was no significant difference was observed in ash content in different pretreatments. High content of ash was observed in foxtail millet based idly (3.14) as compared to rice based idly (1.25).

Calcium content

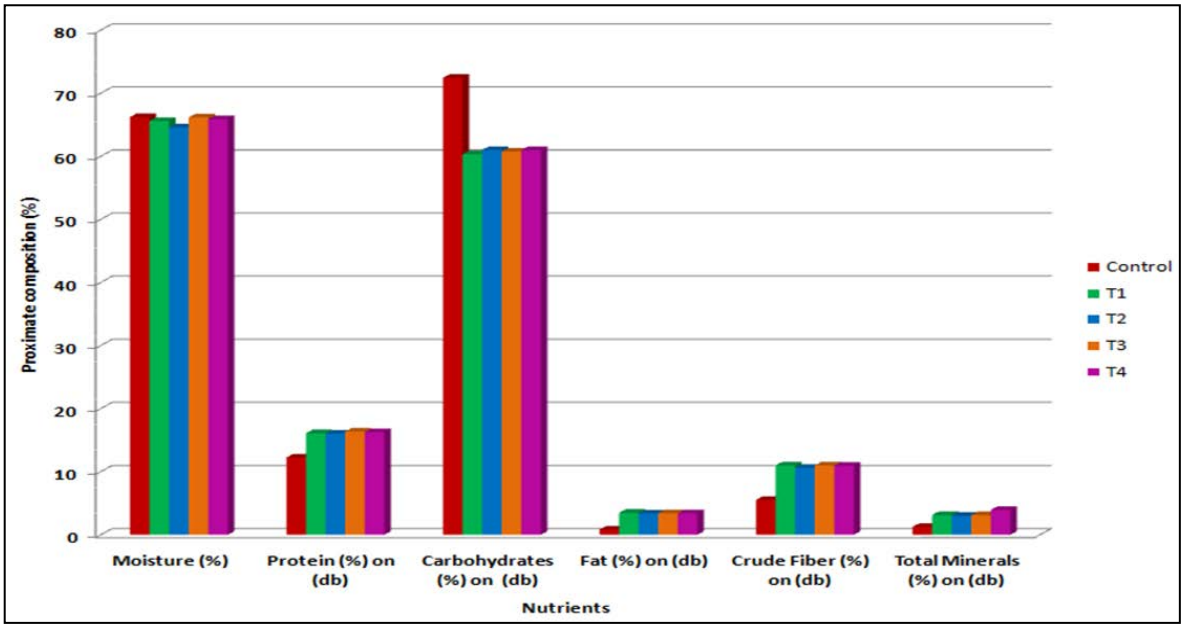
There was no significant difference was observed in calcium content in different pretreatments. High content of calcium was observed in foxtail millet based idly (63.1%) as compared to rice based idly (48.4%)

Iron content

There was no significant difference was observed in iron content in different pretreatments. But as compared to rice based idly (2.77%), foxtail millet based idly had high content of iron (4.24%).

Table 2: Proximate composition of idly sample

Nutrientscc	Control	T1	T2	T3	T4
Moisture	66.23±2	65.61±3	61.61±1	63.17±1	62.87±3
Protein	12.26±0.02	16.11±0.05	15.04±0.01	15.36±0.02	14.28±0.03
Carbohydrate	72.44±2	60.33±1	61.01±2	63.76±1	62.97±2
Fat	0.83±0.03	3.49±0.01	3.38±0.02	2.42±0.01	2.40±0.02
Crude fibre	5.54±0.01	11.01±0.02	13.61±0.03	12.98±0.01	13.96±0.02
Total ash	1.25±0.02	3.14±0.01	3.01±0.02	3.11±0.01	3.94±0.02
Calcium	48.4±0.3	63.1±0.3	61.8±0.3	62.6±0.3	59.7±0.3
Iron	2.77±0.3	4.24±0.1	5.14±0.2	5.20±0.3	4.68±0.2



Graph 1: proximate composition of idly sample

Proximate composition of dosa sample

Moisture content

The moisture content of the foxtail millet based dosa significantly decreases during pretreatment. But rice based idly had high content of moisture (27.36) compared to foxtail millet based dosa (26.31). Low moisture content was observed in roasted sample (23.37).

Carbohydrate content

High carbohydrate content was observed in rice based dosa sample (71.44). Pre-treatment significantly increases the carbohydrate content. High content of carbohydrate was observed in soaking and tray drying sample (62.76).

Protein
High content of protein was observed in foxtail millet based dosa (16.08%) than in rice based dosa (12.31%). Because foxtail millet had high content of protein compared to rice. By applying different pretreatment protein content was slightly decreases due to leaching of protein during processing. Maximum reduction was observed in soaking + roasted sample (14.38%).

Fat content
Pretreatment significantly decreases the fat content it may be due to oxidation and degradation of fat during processing. Maximum reduction was observed in soaking+roasted sample (2.49). High content of fat was observed in foxtail millet based dosa (3.59) compared to rice based dosa (0.89).

Crude fibre
Crude fibre content of raw foxtail millet based dosa was 9.93%. Pretreatment significantly increases the crude fibre content. High content of crude fibre was observed in soaking+roasted sample (11.96)

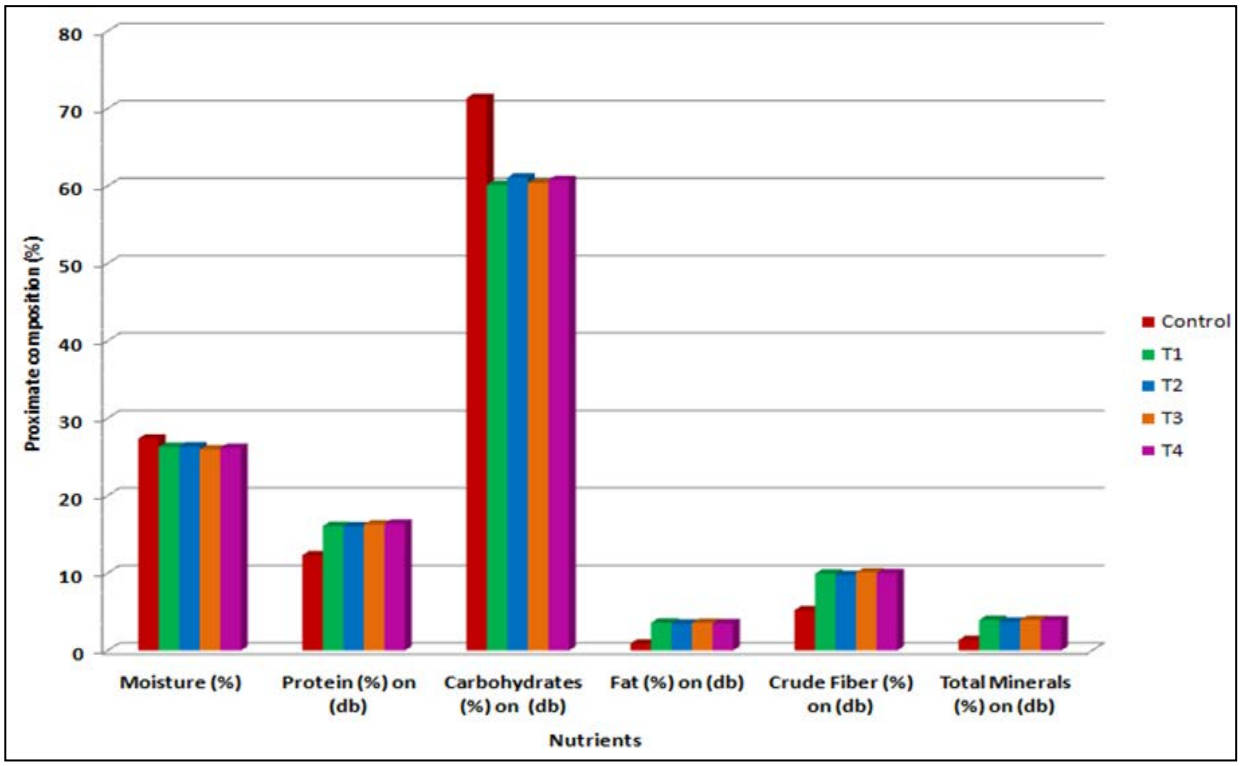
Total ash
There was no significant difference was observed in ash content in different pretreatments. High content of ash was observed in foxtail millet based dosa (3.94%) as compared to rice based dosa (1.35%).

Calcium content
There was no significant difference was observed in calcium content by applying different pretreatments. High content of calcium was observed ssin foxtail millet based dosa (67.31%) as compared to rice based dosa (49.74%)

Iron content
There was no significant difference was observed in iron content in different pretreatments. But as compared to rice based dosa (3.07%), foxtail millet based dosa sample had high content of iron (5.24%).

Table 3: Proximate composition of dosa sample

Nutrientscc	Control	T1	T2	T3	T4
Moisture	27.36±1	26.31±3	23.37±2	25.97±1	24.18±2
Protein	12.31±0.02	16.08±0.03	15.04±0.01	15.16±0.02	14.38±0.03
Carbohydrate	71.34±2	60.13±1	61.21±1	66±0.32	60.77±3
Fat	0.89±0.02	3.59±0.01	3.46±0.03	2.55±0.01	2.49±0.04
Crude fibre	5.21±0.03	9.93±0.02	11.76±0.01	10.08±0.02	9.99±0.01
Total ash	1.35±0.02	3.94±0.03	3.71±0.02	3.96±0.04	3.88±0.03
Calcium	49.7±0.6	67.3±0.2	65.8±0.3	66.5±0.5	64.9±0.7
Iron	3.07±0.4	5.14±0.1	5.04±0.3	4.68±0.6	5.19±0.2



Graph 2: proximate composition of dosa sample

Conclusion

The physical, nutritional and sensory properties of ready to cook breakfast Idli and Dosa samples were prepared from differently pre-treated foxtail millet were evaluated. It could be concluded that, the foxtail millet treated with soaking and followed by drying results in better quality semolina. The semolina prepared after hydrothermal treatment (soaking +drying) replace the rice semolina in traditional breakfast Idli and dosa. There was an improvement on the nutritional contents of the foxtail millet based Idli and Dosa as the nutritional analysis showed an increase in nutritional values of the samples compared to the control sample (rice based idli and Dosa) with the exception of the carbohydrate content. The mean sensory values of Idli for overall acceptability of control, T1, T2, T3 and T4 were found as 8.4, 7.3, 7.6, 8.2 and 7.9 respectively on the Hedonic scale. However the sample 'T3' has better value for over all acceptability as compared to other samples. The mean sensory values for Dosa for overall acceptability control, T1, T2, T3 and T4 samples were found as 8.3, 7.4, 7.7, 8.1 and 7.9 respectively on the Hedonic scale. However the sample 'T3' has better value for over all acceptability as compared to other samples. The overall acceptability of data on sensory quality obtained by a panel of 25 members showed that both millet and rice-based Idli/Dosa was 'Liked Moderately'.

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