



Development and Evaluation of Fermented Little Millet Based Cold Extrudates

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Authors' contributions

This work was carried out in collaboration among all authors. Author MK has developed the product and performed the analysis. Author BAK has designed the study and wrote the protocol. Author WJS has wrote the first draft of the manuscript. Author MT managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Fermentation is a promising food processing method that can be used to diversify the food and improve nutritional property. Pasta a convenient and ready to cook food was developed using durum wheat and fermented little millet flour. Different formulations were prepared by mixing the ingredients in four combinations. Fermentation of little millet flour showed a significant decreased in pH while titratable acidity increased as fermentation goes on. Leavening of flour improved and also internal batter temperature ascend with increased in fermentation time. The result showed that combination with in the experimental samples 10% and 15% fermented little millet flour has higher acceptability as compared to other combination.

Keywords: Millets; little millet; fermentation; cold extrusion; pasta; sensory evaluation.

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1. INTRODUCTION

Millet is a used to describe a wide range of small sized grains that form heterogeneous group and referred as coarse cereals. Most of the millets are grown in different regions of the world from east to west [1]. Millets are major food for millions of people especially those living in hot and dry areas of the world with little rain fall as they are grown in marginal agricultural areas and conditions where other cereal crops fail to produce substantial yields [2]. Millets are highly nutritious food which help in reducing malnutrition, combat micronutrient deficiency in common population and control conditions like obesity, diabetes, cardiovascular and other life style diseases [3]. They can be substituted for wheat in celiac patients as it is gluten free [4].

Little millet is one of the important cereal crops grown in the tropics as it is highly drought tolerant [3]. Superior nutritional and medicinal value along with good storage feasibility of this grain leads to consider it as an important staple food by ancient people [5]. It has high nutritive value compared to cereals like rice and wheat in terms of protein, fat, carbohydrates and crude fibre, apart from minerals and vitamins. It also contains antioxidants and phytochemicals such as phenolic acids, flavonoids, tannins and phytates [6].

In the developed countries, many convenience foods have been developed by extrusion technology as these extruded products are extremely popular among the consumers. These products include spaghetti, macaroni, vermicelli, pasta and noodles [7]. Extrusion cooking process is used worldwide to produce expanded snack foods, modified starches ready to- eat cereals, baby foods, pastas and pet foods [8].

Pasta is an Italian word to describe a cooked, extruded and dried product containing wheat flour or semolina and water. Italy consumes the most with 28.5 Kg /person/ year and the consumption is growing in worldwide due to its distinct taste and convenience. The pastas besides being good energy source due to high starch content provide dietary fiber, protein and lipids as essential fatty acids along with important micronutrients like vitamins, minerals, antioxidants and phytochemicals. Pasta is a source of complex carbohydrates and the interest it is increasing due to its low glycemic index. Pasta and other cereal products served

as a staple food and an excellent choice for incorporating microencapsulated nutraceuticals [9].

The pasta products are becoming popular in current changing lifestyle because they are healthy, tasty and convenient for transportation and preparation. Consumers are becoming increasingly health conscious and are demanding natural, wholesome and health-promoting foods [10]. Studies on fermentation and development of product from fermented little millet are minimal. So, the present study was designed to explore the acceptability of fermented little millet-based pasta as a convenient food due to increasing demand for pastas.

2. MATERIALS AND METHODS

2.1 Procurement of Raw Materials

The little millet grains was acquired from Millet Processing and Incubation Centre (MPIC), Professor Jayashankar Telangana State Agricultural University (PJTSAU), Rajendranagar and durum wheat flour from local market of Hyderabad (17° 23' 13.7040" N and 78° 29' 30.0624" E).

2.2 Fermentation of the Grain

The little millet grain was grounded to fine flour followed by sieving with a 5.0mm sieve. From this 100.0 grams of little millet flour was taken and mixed thoroughly in 500 ml of distilled water. The little millet batter was allowed to stand for fermentation in water bath shaker at different time intervals of 0, 6, 12, 18, 24 and 30 hours at a temperature of 30°C. Aliquots of the fermenting slurry were drawn at every 6hr for analysis of physico-chemical parameters. The fermentations were carried out in triplicate. The suspension after fermentation was dried at 50°C in a tray dryer until constant weight was obtained [11].

2.3 Analysis of Physico-Chemical Parameters

2.3.1 pH

The pH was determined using pH 700 Digital meter at room temperature. The pH meter was standardized using pH buffer of 4.0, 7.0 and 9.2 [12].

2.3.2 Titratable acidity

The acidity of the millet flour samples was determined by titrating with 0.1N NaOH adding phenolphthalein indicator to determine the end point [12].

2.3.3 Leavening

The level of leavening of the fermenting meal was determined by placing a short meter rule along the side of the bottle containing the fermenting meal and the level of the meal was read on the meter rule at 0, 6, 12, 18, 24 and 30 hour. The difference between the initial reading and the final reading was recorded as the level of leavening [13].

2.3.4 Internal batter temperature

At 0, 6, 12, 18, 24 and 30hour, the temperature of the fermenting little millet flour batter was taken using a clinical thermometer [14].

2.4 Development of Fermented Little Millet Incorporated Extrudates

The composite flours were prepared with fermented little millet flour and durum wheat semolina in different combinations as given in Table 1.

2.5 Sensory Evaluation of Extrudate

Sensory evaluation was done by evaluation using 9-point hedonic scale at Post Graduate and Researc Centre, PJTSAU where each product was coded with three-digit number and was tested by 15 semi-trained panelists. They were provided water to rinse the mouth for avoiding over lapping of taste. They were asked to score the product based on the sensory parameters like colour, flavour, texture, appearance, taste and overall acceptability from 1 to 9, 1 being I dislike extremely *i.e.*, very bad and 9 being I like extremely *i.e.*, the product is excellent in particular attribute [15].

3. RESULTS AND DISCUSSION

3.1 Changes in Physico-Chemical Parameters of Little Millet during Fermentation

Physical characteristics such as pH, acidity, leavening and internal temperature are key factors that influence the fermentation process. The mean scores of physical characteristics during fermentation of little millet flour at 30°C temperature in different time intervals were reported in Table 2.

3.1.1 pH

pH is one of the key and leading factor for fermentation. Table 2 indicates that continuous decrease of pH was observed up to 18 hours but from 24 to 48 hours pH was constant (4.03 ± 0.03). The range of pH was 6.14 ± 0.01 (0hrs) to 4.03 ± 0.03 (48hrs). Statistically significant difference ($p \leq 0.05$) was seen between the time intervals.

3.1.2 Titratable acidity

Mean scores of acidity were presented in Table 2. Results showed that acidity increased with increase in the time of fermentation. Continuous increase of acidity was seen from 0 hour (0.01 ± 0.04) to 18 hours (0.56 ± 0.01) fermentation time, whereas at 24 hours (1.06 ± 0.03) acidity was increased but after that acidity decreased at 48 hours (0.98 ± 0.01). Due to the activity of lactic acid bacteria accumulation of acid in the media may be the reason for decrease in pH and increase in acidity up to 18 hours of fermentation [16].

Similar results were reported by [17] in naturally fermented pearl millet flour. Fermentation was done from 0 – 96 hours time intervals. With increase in the time for fermentation pH decreased from 5.00 ± 0.8 to 3.48 ± 0.3 , whereas acidity increased from 0.090 ± 0.002 to 0.819 ± 0.04 .

Table 1. Proportions of the ingredients used in fermented little millet based extrudates

Sample code	Durum wheat semolina (g)	Fermented flour (g)	Salt (g)	Water (ml)
CNP	100.0	-	0.5	50.0
FLP ₁	90.0	10.0	0.5	50.0
FLP ₂	85.0	15.0	0.5	50.0
FLP ₃	80.0	20.0	0.5	50.0
FLP ₄	75.0	25.0	0.5	50.0

Table 2. Physical characteristics of batter during fermentation of little millet

Time (in hrs)	pH	Titrateable acidity	Leavening	Internal batter temperature (°C)
0	6.14d±0.01	0.01a±0.04	0.66b±0.03	23.33a±0.01
6	6.02c±0.02	0.22b±0.03	0.50a±0.02	27.00b±0.00
12	4.18b±0.05	0.51c±0.10	0.65b±0.03	27.00b±0.02
18	4.08a±0.08	0.56c±0.01	0.83c±0.03	27.00b±0.03
24	4.03a±0.05	1.06e±0.03	0.83c±0.07	28.33c±0.03
48	4.03a±0.03	0.98d±0.01	1.06d±0.05	28.67d±0.01
Mean	4.51	0.11	0.65	25.89
S.E.of mean	0.23	0.06	0.07	0.32
CD	0.16	0.44	0.14	0.51
CV%	1.95	2.02	12.24	1.10

Note: Values are expressed as mean ± standard deviation for all the three determinants. Mean within the same column followed by common letter do not significantly differ at p≤0.05

Similar results in natural fermented khoz by using different millets such as finger millet, pearl millet, maize and sorghum at different time intervals such as 0, 5, 10, 15 and 20 was reported by [16]. In finger millet pH decreased from 6.2 to 4.8 whereas acidity increased from 0.56 to 2.53. In pearl millet pH decreased from 6.2 to 4.3 whereas acidity was increased from 1.36 to 5.9. In maize pH decreased from 6.4 to 4.7 and acidity was increased from 1.06 to 2.5. In sorghum pH decreased from 6.5 to 4.9 whereas acidity was increased from 1.23 to 3.13.

3.1.3 Leavening

Leavening is one of the physical factors for determination of fermentation process. Table 2 showed that without fermented little millet batter (0 hours) had 0.66±0.33 of leavening. From 0 to 6 hours leavening was decreased to 0.50±0.02, whereas from 12 (0.65±0.03) to 18 hours (0.83±0.03) leavening increased and no significant change was observed in 24 hours (0.83±0.07) of fermentation but it again increased at 48 hours (1.06±0.05) of fermentation. Improved leavening of fermented batter might be due to production of lactic acid and carbon dioxide by microorganism during fermentation process [17 & 18].

3.1.4 Internal batter temperature

Internal temperature of little millet batter was changed during fermentation process. Mean scores of internal temperature of fermented little millet batter (0 hours) was 23.33°C. The initial internal temperature was constant from 6 to 18 hours, where as it increased at 18 (28.33°C) and

48 hours (28.67°C) (Table 2). Results showed that statistically there was no significant difference (p≤0.05) between time intervals of 6, 12 and 18 hours.

Fermentation at 30°C for 24 hours was further studied because of following positive traits:

1. Fermentation was stopped after 24 hours.
2. Physico-chemical properties like pH and leavening at 24 hours were ideal for product development.

3.2 Development of Fermented Little Millet Incorporated Extrudates

Although the nutritive value of millets is well noted yet the utilization of millets is not wide spread. Various millet flours can be exploited for industrial uses in different food products by determining their functional characteristics [19]. Development of acceptable food products through the thoughtful uses of such foods and later on its commercialization may serve the people suffering from nutritional disorders in an excellent way. There is tremendous opportunity to develop functional food targeted for those at risk for different nutritional problems.

The millet grains offer many opportunities for utilization in diversified products. Millets are suitable for the production of flakes and extruded products such as noodles and vermicelli. Ready to eat and ready to cook food products persist to be in trend and so production of pasta continue to meet its demand from consumers. Therefore the present study was carried out to develop a cold extrudate product with different composition of wheat flour and fermented little millet flour.

3.3 Sensory Quality Characteristics of Fermented Little Millet (FLP) Incorporated Extrudates

Fermented little millet based cold extrudate (pasta) were prepared by incorporating fermented little millet flour at 4 different combinations and subjected to sensory evaluation with control extrudate made with 100% wheat flour. The sensory scores of the developed pasta with four combinations of fermented little millet flour, FLP₁ (10%), FLP₂ (15%), FLP₃ (20%) and FLP₄ (25%) along with control were presented in Fig. 1A. Comparison of sensory score between the experimental samples was presented in 1B and the percentage change in sensory properties when compared with the control were presented in Fig. 2.

Among the five samples highest mean sensory score for colour was given to FLP₁ (8.40±0.19) and FLP₂ (8.40±0.19) whereas lowest score was given to FLP₄ (5.86±0.16). The range of mean sensory score for colour was 5.86±0.16 (FLP₄) to 8.40±0.19 (FLP₂ & FLP₁). There was significant difference between the control sample and the experimental sample. Whereas, no significant difference was observed between FLP₁ and FLP₂ at $p \leq 0.05$ (Fig. 1).

The ascending order of mean sensory scores for flavour was 5.33±0.12 (FLP₄) > 6.26±0.15 (FLP₃) > 7.80±0.20 (CNP) > 7.89±0.26 (FLP₂) > 7.96±0.22 (FLP₁). The mean highest sensory for flavour was given to FLP₁ (7.96±0.22) and lowest score was given to FLP₄ (5.33±0.12). The mean sensory score for texture in ascending order is FLP₂ > FLP₁ > CNP > FLP₃ > FLP₄ (7.53±0.21 > 7.33±0.21 > 7.46±0.21 > 6.00±0.13 > 5.53±0.16). The highest score for appearance was given to CNP (8.86±0.25) and FLP₂ (7.63±0.23) whereas lowest score was given to FLP₄ (4.80±0.14).

The range of mean sensory score for taste was 5.40±0.13 (FLP₄) to 8.93±0.22 (CNP). The control sample scored high for taste than the experimental sample, whereas FLP₂ (7.93±0.23) scored high followed by FLP₁ (7.90±0.22) among the experimental samples. Whereas, FLP₃ and FLP₄ (6.20) scored least for overall acceptability the samples. The mean sensory scores for overall acceptability shows that control sample scored high among all the samples, but FLP₁ (7.90±0.22) scored high followed by FLP₂ (7.20±0.26). There was

significant difference between the control sample and the experimental sample. Whereas, no significant difference was observed between FLP₁ and FLP₂ at $p \leq 0.05$ (Fig. 1A).

The Fig. 2 clearly shows that among the five combinations all the experimental samples have scored lowest than the control sample except colour, flavor and texture in FLP₁ and FLP₂, where the scores were increased than the control sample. There was 9.66 % increase in colour, nearly 2 % increase in flavor was seen. The decrease in sensory scores was more as the percentage incorporation of fermented little millet was increased. The overall acceptability score clearly shows that only 3.6 to 3.2 % decrease were seen in FLP₁ and FLP₂ when compare to control whereas nearly 24% decrease was seen in FLP₃ and FLP₄ (Fig. 2). Even though the FLP₁ and FLP₂ samples scored less than control sample in some parameter but the scores were more than 7 and 8 mean they were liked extremely to very much.

The mean sensory scores of experimental samples were compared and graphically represented in Fig. 1B, which clearly indicates FLP₃ and FLP₄ had lowest scores whereas the higher scores were given to FLP₁ and FLP₂ and there is no significant difference between these samples. Thus these two samples were accepted and carried for further physical, functional, nutritional and storage studies.

The effect of fermentation of cassava roots on the quality characteristics of flour and pasta was investigated [20]. Cassava roots were fermented under natural condition for a period of 12, 36 and 60 h. The moisture content, carbohydrate, water absorption capacity, swelling and solubility index of fermented flour increased with an increase in fermentation period. Also, as fermentation progressed, increase in pasting viscosities of cassava flour was observed. The duration of fermentation process significantly affected textural properties and cooking loss of cassava pasta. Sensory assessment showed that cassava roots fermented for 36 h gave pasta with the most acceptable qualities.

The replacement of semolina with malted finger millet flour in pasta was studied by [21]. The changes in nutritional constituents and bioactive compounds (TPC, Radical. Scores for overall acceptability of pasta at 40 percent level of replacement was highest whereas all the treatments of pasta were also found to be acceptable by panel members.

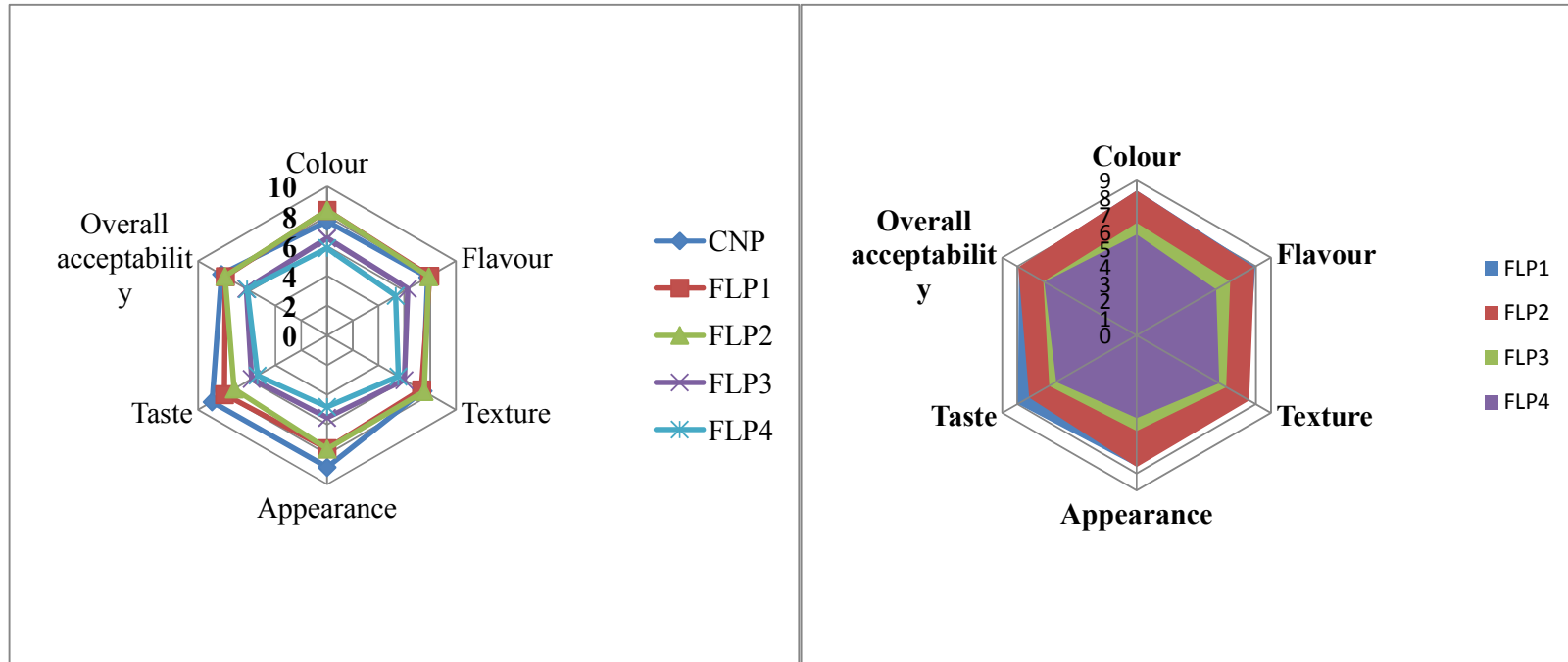


Fig. 1A. &1B. Sensory parameters of fermented little millet incorporated cold extrudates

Note: Values are expressed as mean \pm standard deviation of 15 determinations.

CNP: Durum wheat- 100%

FLP1: Durum wheat- 90%, fermented flour- 10%

FLP2: Durum wheat- 85%, fermented flour- 15%

FLP3: Durum wheat- 80%, fermented flour- 20%

FLP4: Durum wheat- 75%, fermented flour- 25%

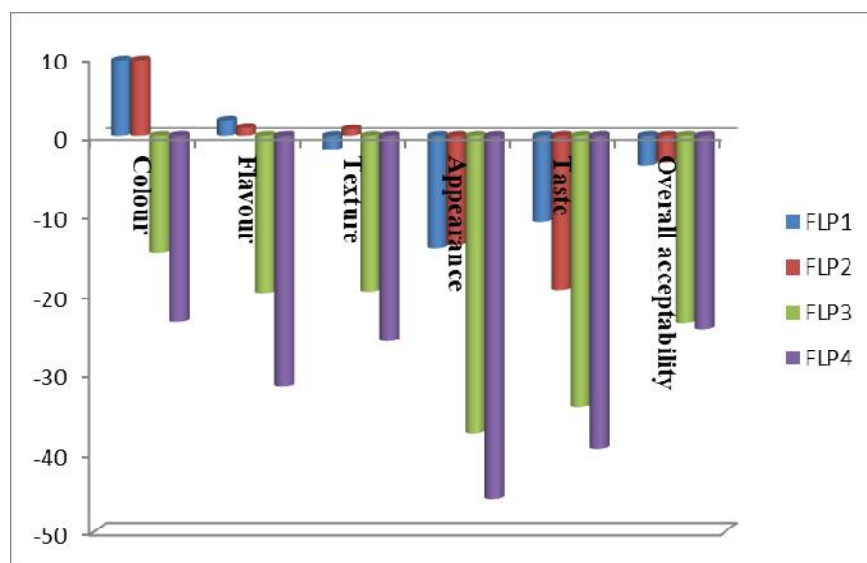


Fig. 2. Percentage change of sensory parameters of fermented little millet incorporated cold extrudates when compare to control

Note: CNP: Durum wheat- 100%

FLP1: Durum wheat- 90%, fermented flour- 10%

FLP2: Durum wheat- 85%, fermented flour- 15%

FLP3: Durum wheat- 80%, fermented flour- 20%

FLP4: Durum wheat- 75%, fermented flour- 25%

4. CONCLUSION

The present study showed that the pH of fermented little millet decreases with increased in titratable acidity as fermentation time increases. The leavening of little millet flour rise with increased in fermentation time. Similarly the internal batter temperature also mount with increased in fermentation time. Pasta with 10% and 15% fermented little millet flour was more acceptable after control pasta which showed higher sensory score in par with the other different combinations. And it is concluded that addition of fermented little millet to a certain amount was accepted by the panel member as fermentation helps improve nutrient composition and positively adds to health.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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