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Effect of proportion of ingredients on physico-chemical changes of batter and Paddu made of little millet as compared to rice

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ABSTRACT

The present study was undertaken to find out the effect of proportion of ingredients on physico-chemical changes of batter and Paddu made of little millet as compared to rice. The little millet Paddu was prepared by addition of little millet to pulse mix (black gram Dhal, Bengal gram Dhal, red gram Dhal, fenugreek seeds and rice flakes) in the ratio of 2:1, 3:1, 4:1, 5:1 and 6:1 in comparison to rice. The volume of little millet batter increased with increase in proportion of addition of little millet where as the volume of batter decreased with increased proportion of rice. Significant difference in the viscosity of batter was observed between cereals, between fermentation and also between proportion of ingredients. Significant decrease in the pH of little millet and rice batter was observed after fermentation whereas it did not show significant differences between little millet and rice and between proportion. Increased proportion of cereal to pulse ratio did not show any significant differences in the physical characteristics of Paddu. However texture analysis by instrument revealed that hardness of Paddu increased with increased proportion of cereals to pulse. Hence 6:1 proportion of little millet and pulse mix was considered as optimum ingredients for the preparation of little millet Paddu.

Keywords: Little millet; Paddu; fermentation; proportion

INTRODUCTION

Production of fermented foods is one of the oldest food processing technologies known to man. The traditional fermented foods contain high nutritive value and develop a diversity of flavours, aromas and texture in food substrates. Many of the indigenous fermented products of cereals are valued for the taste and aroma. By combining rice with pulse the overall protein quality is improved. The diversities of the population of India have given rise to a large number of traditional fermented foods (Soni and Sandhu1990). Paddu is one of the famous fermented shallow fat fried products in southern part of India which is generally consumed as a breakfast or as a snacks item. Little millet, *Panicum Sumatrence* L is an important staple

regional food crop of northern Karnataka. This nutritious grain has been ignored by farmers because of distribution of rice in PDS system and shifting of cropping pattern to cash crops. However this crop holds comparative advantage over commodity crops in terms of high adaptation to range of agro-ecological conditions. Since little millet is being used traditionally for preparation of fermented foods an attempt was made to prepare fermented Paddu from indigenous local millet with an objective to study the effect of proportion of ingredients on physico-chemical changes of batter and Paddu of little millet as compared to rice.

MATERIAL and METHODS

Procurement of raw ingredients

The little millet, *Panicum Sumatrence* L local cultivar *malli savi* was collected from local farmers of Savnoor Taluk, Haveri district and stored in sack bag and dehusked by conventional method in emery mill. Decorticated grains were separated from the husk through winnowing. The cleaned grains were stored in refrigerator at 5°C. Other ingredients like rice and pulses, black gram Dhal, Bengal gram Dhal, red gram Dhal, fenugreek seeds and flaked rice were procured in bulk from the local market and stored in refrigerator at 5°C. Non-stick Paddu skillet was purchased from local market for the study.

Proportion of addition of cereals to pulses

The cleaned dehusked little millet grains or rice and pulses in the ratio of 2:1, 3:1, 4:1, 5:1 and 6:1 were taken by weight. It was also compared with the Paddu prepared from rice and its ratio to pulse was 2:1, 3:1, 4:1, 5:1 and 6:1 (Table 1).

Method of preparation of Paddu

The little millet and rice were soaked separately and other ingredients were soaked separately. Soaking and fermentation duration was 6 and 12 h respectively. All the ingredients were washed twice with distilled water before soaking. Soaked grains were ground separately in a wet grinder to a fine paste. Ground pulse and other ingredients were mixed together thoroughly with little millet or rice batter and covered with aluminium foil. The mixed batter was allowed to ferment in an incubator at 30 ± 2°C for 12 h. The fermented batter was used further to study batter properties and preparation of Paddu.

Batter properties of little millet and rice

For the different proportion of ingredients the Paddu batter properties viz volume, viscosity, colour and pH were studied for both little millet and rice batters.

Increase in volume: A 20 ml aliquot of freshly prepared batter of different ratios of batter was transferred to 50 ml measuring

cylinders and covered with aluminium foil, kept in an incubator at 30 ± 2°C for 12 h and increase in volume was noted.

Per cent increase in volume: Per cent increase in volume was calculated using following equation:

$$\text{Per cent increase in volume} = \frac{\text{Final volume} - \text{initial volume}}{\text{Initial volume}} \times 100$$

Viscosity of batter: The batter was checked for the viscosity before and after 12 h of fermentation. Measurements were taken using Brookfeiled DV III Rheometer, spindle used was LV-4 (64) and was allowed to rotate at the speed of 50 rpm. The temperature at which the viscosity was measured was 28 ± 2°C (Nagaraju and Manohar 2000). The viscosity of batter was measured in terms of centipoises (cP) after allowing the spindle to rotate in the batter for one minute.

Colour of batter: The colour of batter for each sample was recorded using a Hunter Lab Colorimeter model DP-9000 D25A in terms of L (lightness, ranging 0-100 indicating black to white), a (+a, redness and –a, greenness) and b (+b, yellowness and –b, blueness).

pH: The pH of different sets of batter was measured directly before and after 12 h of fermentation using pH strips.

Preparation of Paddu

The non-stick Paddu maker was pre-heated and approximately 2 drops of oil were placed in each of the mould of the Paddu skillet and after few seconds the fermented batter was poured with the help of round spoon in each impression and Paddus were baked on either side till the golden brown colour making sure to cover the Paddu skillet with a lid.

Evaluation of little millet Paddu

Little millet Paddu was evaluated objectively for the texture, using texture analyser.

Weight of Paddu: The total weight of Paddu was obtained by weighing all the Paddus on digital weighing balance.

Texture analysis: Textural profile of Paddu was determined using a texture analyser (TA.XT2i, Stable Micro System and Survey, UK). Parameter recorded included hardness ie load at maximum load (N) and energy to break point (J).

Statistical analysis: The experiment was conducted in three replications of each blend ratio and cereal. The experimental data were statistically analysed using Microsoft Excel 2007 (Microsoft Crop, Redmond, WA, USA).

RESULTS and DISCUSSION

The increase in volume of batter for different proportions irrespective of cereals and fermentation (Table 2) was significant. The mean increase in volume ranged from 28.60 to 32.57 ml between proportions. From the data it was found that the initial volume (20.00 ml) of little millet batter increased with increase in proportion of addition of little millet and batter volume reduced with increase in proportion of rice.

Fermentation increased the volume of batter irrespective of rice and little millet and proportion was significant. The mean increase in volume ranged from 20.00 to 40.35 ml between before and after fermentation. The increase in volume of batters of different cereals irrespective of proportion and fermentation was found to be significant. The mean increase in volume of batter ranged from 27.05 to 33.33 ml between cereals. The increase in volume of little millet and rice batter after fermentation ranged from 44.80 to 48.40 ml and 26 to 45.50 ml respectively. The interaction between cereals and fermentation, between cereals and proportions, between fermentation and proportion and between cereal, proportion and fermentation was significant. Kumar et al (2005) also reported that surface microflora of the unpolished rice was the contributing factor for higher volume of batter.

Fig 1 depicts per cent increase in volume of little millet batter in comparison to rice batter. Per cent increase in volume irrespective of cereals and proportion increased significantly after fermentation. Per cent increase in volume of little millet batter increased with increase in little millet. Whereas per cent increase in volume of rice batter decreased significantly proportion of rice. The per cent increase in volume of batters of different cereals irrespective of proportion and fermentation was found to be significant. The per cent increase in volume of batter prepared from different proportions of ingredients irrespective of cereals was found to be statistically significant.

Observations on colour of little millet batter before and after fermentation in comparison to rice are presented in Table 3. The colour was measured in terms of Hunter L (lightness, ranging 0 to 100 indicating black to white), a (+a: redness and –a: greenness) and b (+b: yellowness and –b: blueness). The maximum value for lightness ie 100 indicates white. Therefore decrease in L value indicates a decrease in whiteness of the product. In the same way an increase in the Hunter b value indicates that there is an increase in yellowness in the product. The whiteness increased in the batter prepared from rice with the increased proportion of addition of rice in both the batters before and after fermentation. Whereas no much difference in the whiteness of the batter prepared from little millet with varying proportion of addition of little millet was observed. The Hunter b value decreased in both rice and millet

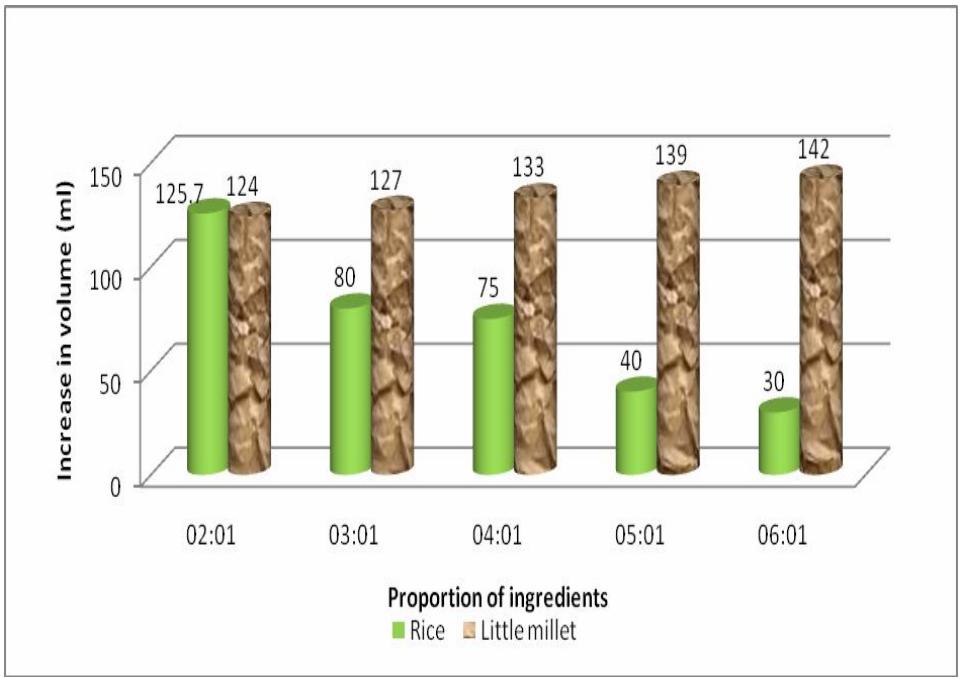

Fig 1. Volume of little millet batter in comparison to rice batter

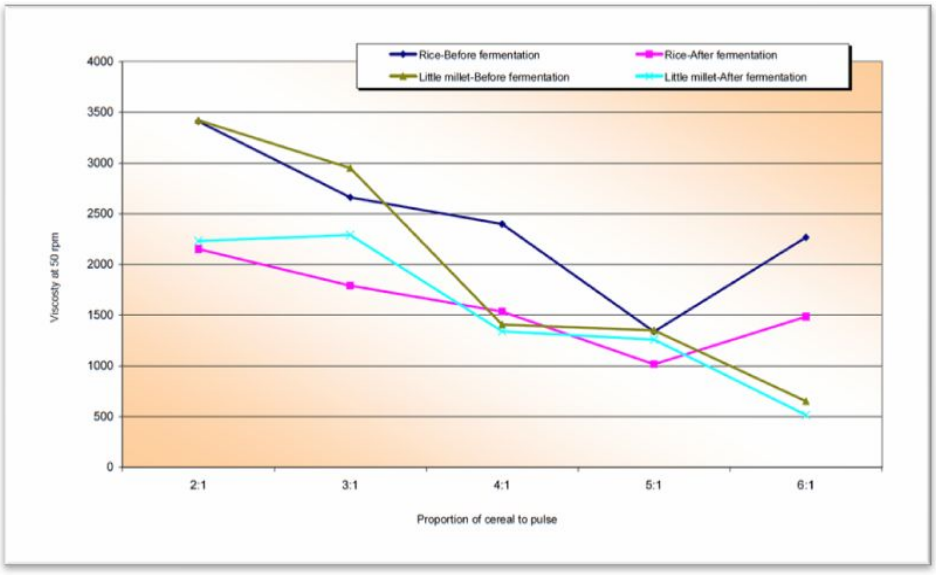

Fig 2. Viscosity of little millet batter before and after fermentation in comparison to rice

Table 1. Proportion of cereal and pulse mix ratio*

Ingredients	Proportion (g)				
	2:1	3:1	4:1	5:1	6:1
Dehulled little millet grains/rice	59.46	68.78	74.58	78.56	81.48
Black gram Dhal	29.72	22.92	18.64	15.72	13.58
Bengal gram Dhal	2.98	2.32	1.86	1.58	1.36
Red gram Dhal	2.98	2.32	1.86	1.58	1.36
Fenugreek seeds	1.78	1.38	1.12	0.94	0.82
Rice flakes	3.10	2.38	1.94	1.64	1.4
Total	100	100	100	100	100

*Pulse mix includes fenugreek seeds and rice flakes

Table 2. Volume (ml) of little millet batter in comparison to rice batter

Type of cereal	Fermentation	Cereal/pulse mix					Mean
		2:1	3:1	4:1	5:1	6:1	
Little millet	Before	20.00	20.00	20.00	20.00	20.00	33.33
	After	44.80	45.40	46.60	47.80	48.40	
Rice	Before	20.00	20.00	20.00	20.00	20.00	27.05
	After	45.50	36.00	35.00	28.00	26.00	
Mean for proportion		32.57	30.35	30.4	28.95	28.6	
Mean F	20.00						
	40.35						

	SEm	$CD_{0.01}$
Factor C	0.09	0.35**
Factor F	0.09	0.35**
Factor P	0.15	0.55**
C x F	0.13	0.49**
C x P	0.21	0.78**
F x P	0.21	0.78**
C x P x F	0.29	1.10**

Values are mean of three replications, Factor C= Cereal (between rice and little millet), Factor F= Fermentation (between before and after fermentation), Factor P= Proportion (between proportions), C x F= Cereal x fermentation, C x P= Cereal x proportion, F x P= Fermentation x proportion, C x P x F= Cereal x proportion x fermentation

Table 3. Colour of little millet batter in comparison to rice batter

Cereal/pulse mix	Little millet						Rice					
	Before fermentation			After fermentation			Before fermentation			After fermentation		
	L	a	b	L	A	b	L	a	b	L	a	b
2:1	67.41	-0.81	12.33	66.87	-0.75	12.91	67.8	-1.45	12.28	66.58	-1.47	11.84
3:1	67.56	-0.79	11.83	66.86	-0.92	12.3	69.51	-1.33	11.35	67.45	-1.46	11.38
4:1	67.71	-0.84	11.23	67.52	-0.76	11.84	69.35	-1.52	10.92	68.05	-1.36	10.82
5:1	67.61	-0.91	11.61	67.8	-0.84	12.3	69.84	-1.33	10.59	69.59	-1.31	10.54
6:1	67.1	-0.87	11.32	67.55	-0.8	12.08	70.09	-1.36	10.29	69.41	-1.24	10.55

Values are mean of three replications, L= Lightness, ranging from 0 to 100 indicating black to white, a= (+a: redness and –a: greenness), b= (+b: yellowness and –b: blueness)

Table 4. Changes in pH of Paddu batter at various proportions

Cereal/pulse mix	Fermentation	2:1	3:1	4:1	5:1	6:1	Mean cereal
Little millet	Before	6.00	6.00	5.50	5.50	5.50	5.1
	After	4.50	4.50	4.50	4.50	4.50	
Rice	Before	5.93	6.00	6.00	6.00	6.00	5.24
	After	4.50	4.50	4.50	4.50	4.50	
Mean for proportion		5.23	5.25	5.13	5.13	5.13	
Mean F	5.84						
	4.50						

	SEm	$CD_{0.01}$
Factor C	0.002	0.01**
Factor F	0.002	0.01**
Factor P	0.004	0.01**
C x F	0.003	0.01**
C x P	0.01	0.02**
F x P	0.01	0.02**
C x P x F	0.01	0.03**

Values are mean of three replications, Factor C= Cereal (between rice and little millet), Factor F= Fermentation (between before and after fermentation), Factor P= Proportion (between proportions), C x F= Cereal x fermentation, C x P= Cereal x proportion, F x P= Fermentation x proportion, C x P x F= Cereal x proportion x fermentation

batters as well as before and after fermentation which indicated there was decrease in yellowness with increase in addition of proportion of cereal. The Hunter –a value varied with varying proportion of addition of rice and little millet as well as before and after fermentation. The rice batter both before and after fermentation with varying proportion of addition of rice had more greenness than the little millet batter. Fermentation decreased the whiteness of the batter of little millet and rice. Increased proportion of rice to pulse ratio enhanced the Hunter L value that can be attributed to the whiteness of the original colour of the rice grains as compared to little millet.

The observations on viscosity of little millet batter in comparison to rice as well as before and after fermentation are depicted in Fig 2. Viscosity of the batter was taken at 50 rpm. The viscosity of both little millet and rice batters before and after fermentation increased with the increase in the addition of little millet and rice. Rice batter was more viscous in both batters before and after fermentation with all the proportion when compared with little millet batters. This finding is in accordance with the study by Nagaraju and Manohar (2000). The fermented little millet batter was more viscous than the unfermented batter at all different proportions. The viscosity of batter between rice and little millet, between before and after fermentation

and between proportions was statistically highly significant. The interaction between cereal and fermentation, between cereal and proportion, between fermentation and proportion and between cereal, proportion and fermentation was also highly significant. Similar results were reported by Ghosh and Chattopadhyay (2010).

The fermentation decreased the pH of the batter irrespective of cereals and fermentation (Table 4) and was found to be significant ($p < 0.01$). The mean decrease in pH of batter ranged from 5.84 to 4.50 between before and after fermentation. The pH of the batter before fermentation ranged from 5.5 to 6 and after fermentation the pH was 4.5. The decrease in the pH of the batter of different cereals irrespective of proportion and fermentation was found to be significant ($p < 0.01$). The mean decrease in pH of batter ranged from 5.24 to 5.1 between cereals. The pH of the batter of different proportions irrespective of cereals and fermentation was found to be significant. The mean pH of the batter ranged from 5.13 to 5.25 between proportions. The interaction between cereal and fermentation, between cereal and proportion and between fermentation and proportion was found to be significant. The interaction between cereal, fermentation and proportion was also significant. The changes in volume and pH can be attributed to the higher microbial growth in the little millet batter (Table 3 and 5). The results are also in accordance with those of reported by Kyung Koh and Singh (2009).

Table 5 depicts the physical properties of Paddu for different proportions as well as comparison between millet and rice Paddu. The number of Paddus that could be prepared from the same quantity of batter with varying proportion of ingredients varied. The number of Paddus that were obtained from same quantity of batter with varying proportion of ingredients ranged from 7 to 9. The number of Paddus was significant between proportion and between cereals. The interaction between proportion and cereals was also significant for number of Paddus. The average weight of single Paddu increased with increase in addition of proportion of rice. The average weight of single little millet Paddu varied with varying proportion of ingredients while the average weight of single Paddu of little millet and rice ranged between 7.35 to 9.03 g. The average weight of single Paddu prepared from varying proportion of ingredients with little millet and rice was found to be significant and also between little millet and rice the average weight of Paddu with varying proportion of ingredients was found to be significant. The interaction between proportion and cereal was also significant.

In general the Paddu prepared from little millet was whiter than the Paddu prepared from rice. The whiteness of Paddu increased with the increase in addition of proportion of rice. There was no significant difference in the colour of Paddu prepared from rice and little millet with varying

Table 5. Physical characteristics of Paddu in relation to proportion of cereals and pulse mix

Cereal/pulse mix	# Paddu			Weight of Paddu (g)			Colour					
	Little millet	Rice	Mean	Little millet	Rice	Mean	Little millet			Rice		
							L	a	b	L	a	b
2:1	8.00	7.00	7.50	7.51	8.76	8.13	40.53	5.41	26.26	63.9	5.95	28.22
3:1	9.00	8.00	8.50	8.29	7.54	7.91	58.03	8.33	29.49	65.8	4.9	28.71
4:1	8.00	7.00	7.50	7.35	7.54	7.44	62.62	1.29	19.8	64.42	3.4	25.39
5:1	7.00	8.00	7.50	8.03	9.03	8.53	64.39	0.9	20.29	64.77	3.58	25.05
6:1	8.00	7.00	7.50	7.08	8.72	7.90	66.01	-0.18	17.19	67.04	2.35	23.74
Mean	8.00	7.40		7.65	8.32							

	# Paddu		Weight of Paddu	
	SEm	CD	SEm	CD
Proportion (P)	0.18	0.54**	0.04	0.13**
Cereal (C)	0.12	0.34**	0.03	0.08**
P x C	0.26	0.76**	0.06	0.19**

Values are mean of three replications, Factor C= Cereal (between rice and little millet), Factor Factor P= Proportion (between proportions), P x C= Proportion x cereal

Table 6. Texture analysis of Paddu

Cereal/pulse mix	Load at maximum load (N)			Energy to break point (J)		
	Little millet	Rice	Mean	Little millet	Rice	Mean
2:1	83.77	156.17	119.97	1.12	1.95	1.54
3:1	105.23	189.83	147.53	1.02	1.90	1.46
4:1	123.53	211.60	167.57	1.56	3.20	2.38
5:1	168.83	224.73	196.78	2.83	3.22	3.02
6:1	183.00	252.37	217.68	1.90	2.86	2.38
Mean	132.87	206.94	169.91	1.90	2.86	2.38

	Load at maximum load		Energy to break point	
	SEm	CD	SEm	CD
Proportion (P)	7.60	22.43**	0.20	0.58**
Cereal (C)	4.81	14.19**	0.12	0.37**
P x C	10.75	NS	0.28	NS

Values are mean of three replications, P= Proportion, C= Cereal, P x C= Proportion x cereal, **Significant @ 1%, NS= Non-significant

proportion. The colour of rice and little millet Paddu with varying proportion of ingredients was found to be non-significant. The Paddu prepared from little millet was having higher Hunter b value than the prepared from rice. The Hunter b value increased indicating that there was an increase in yellowness.

Table 6 depicts the texture analysis of the Paddu. Higher the values of load at maximum load (N) and energy to break point (J) harder is the product. So from the data it was found that Paddu prepared from little millet was softer than prepared from rice batter at all proportions. It was also found that the hardness of both little millet and rice Paddu increased with increase in the addition of proportion of little millet or rice. The differences in the value of both load at maximum load (N) and energy break point (J) were significant between rice and little millet Paddu as well as between proportion. The interaction between cereals and proportion was found to be statistically non-significant.

CONCLUSION

The proportion of addition of little millet to pulse was optimized by considering the change in volume of batter after fermentation without affecting the taste and textural quality of Paddu. The maximum increase in the volume of batter was observed in 6:1 proportion and the taste and textural quality of Paddu was on par with the standard procedure of rice ie 4:1. Hence 6:1 proportion of little millet and pulse mix was considered as optimum addition of ingredients for the preparation of little millet Paddu.

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