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Physico-chemical changes of batter and *Paddu* of little millet during progress of soaking and fermentation

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The present study was undertaken to evaluate the physico-chemical changes of batter and *Paddu* of little millet during the progress of soaking and fermentation. For optimization, soaking and fermentation of the optimized proportion of ingredients (cereal: pulse mix) *i.e.*, 6:1 was taken. The variation in duration of soaking time from 4 to 8 h and fermentation to 12 h increased the volume of batter significantly. Significant decrease in the bulk density, specific gravity, pH and increase in titratable acidity in the fermented batter was observed during progress of soaking and fermentation time. The changes in physical characteristics of *Paddu* with respect to total weight and volume of *Paddu*, average weight and volume of *Paddu* and bulk density was observed with variation in duration of soaking and fermentation, however was non-significant. The soft texture with acceptable taste was observed in *Paddu* prepared from 6 h soaked of grains, and it was considered as optimum condition for *Paddu* preparation. The variation in duration of fermentation time from 8 to 24 h by 6 h soaking of grain increased the volume of batter significantly. The *Paddus* prepared from 14 and 16 h of fermented batter were softer, had good expansion, acceptable sour taste and had higher overall acceptability. The optimum duration of soaking and fermentation was 6 h and 12 to 16 h, respectively.

Key Words : Soaking, *Paddu*, Fermentation, Little millet, Batter

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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 developed 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 Sandhu,1989). *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*) is an important staple regional food crop of Northern Karnataka. It is supposed to be a major source of dietary protein and energy. However, decortications of little millet are one of the major constrains for value addition. Astringent taste presence of anti-nutrients are some of the constrains for consumption of little millet. The adverse effect of poor starch and protein digestibility can be overcome by fermentation. Different fermented traditional food and beverages prepared from millets are popular in different parts of the world. Traditionally it is believed that little millet was being used for preparation of *Paddu*. The physico-chemical changes like increase in volume, pH, titratable acidity, bulk density and physical parameters of *Paddu* during various processing condition like duration of soaking and fermentation will definitely have an influence on the quality of the final product. Hence, the present study was planned with an objective to study the physico-chemical changes of batter and *Paddu* of little millet during the progress of soaking and fermentation.

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METHODOLOGY

For optimization, soaking of ingredients was done at durations of 4, 6, and 8 h. The proportion of ingredients optimized for little millet *Paddu* preparation was considered for optimization of processing conditions like soaking time and fermentation time. Little millet and pulse in the ratio 6:1were weighed to make 100 g and soaked separately for various time period *i.e.*, 4, 6 and 8 h in distilled water. After draining the water, soaked ingredients were ground separately in wet grinder to a fine paste. Water was added as and when required. Both the batters were mixed together thoroughly. 150 ml of aliquot of batter was transferred to a clean 500 ml graduated beaker and covered with aluminium foil; rest of the batter was used for the evaluation of the batter. Beakers were placed in an incubator for fermentation at 30 ± 2^{0}C for 12 h. The fermented batter was used to study batter properties and preparation of *Paddu*.

For standardization of fermentation time, the soaking hours optimized for little millet *Paddu i.e.*, 6 h of soaking was considered. Soaked grains were grounded separately in a wet grinder and mixed together. 150 ml of aliquot was transferred in to 500 ml graduated beaker and covered with aluminium foil. The batter was allowed to ferment for 8, 10, 12, 14, 16, 18, 20, 22 and 24 h. The fermented batter was further used to study batter properties and preparation of *Paddu*.

The physical and chemical characteristics of batter were recorded like volume, weight, bulk density, specific gravity, pH and per cent total acidity of both before and after 12 h of fermentation were noted.

Increase in volume:

A 20 ml aliquot of freshly prepared batter from different ratios of batter was transferred to respective 50 ml measuring cylinders and covered with aluminium foil and kept for incubation at 30 ± 2^{0}C for 12 h. and increase in the volume was noted in ml.

Net increase in volume:

Net increase in volume was calculated using the following equation:

$$\text{Net increase in volume} = \text{Final volume} - \text{Initial volume}$$

Per cent increase in volume:

Per cent increase in volume was calculated using following equation:

$$\text{Net increase in volume} = \frac{\text{Final volume} - \text{Initial volume}}{\text{Initial volume}} \times 100$$

Weight of the batter:

Weight of the batter was measured by transferring 20 ml of freshly prepared batter to previously weighed measuring cylinder. Weight of the batter before and after fermentation was noted.

Specific gravity of batter:

The specific gravity of *Paddu* batter was determined by dividing the weight of glass measuring cylinder (50 ml) filled with batter to the weight of the same measuring cylinders filled with water (Kaur *et al*., 2000).

Preparation of *Paddu:*

The non-stick *Paddu* maker was pre heated and approximately 2 drops of oil was 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 the *Paddu* was were baked on either sides till the golden brown colour, while making sure to cover the *Paddu* skillet with a lid.

Evaluation of little millet *Paddu* in relation to soaking and fermentation:

Little millet *Paddu* were evaluated for different physical characteristic like number of *Paddu*, total weight of *Paddu*, total volume of *Paddu*, average weight of one *Paddu*, average volume of one *Paddu* and bulk density of *Paddu* were noted.

Total weight of *Paddu:*

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

Total volume of *Paddu:*

The total volume of *Paddu* was calculated by seed displacement method.

Bulk density of *Paddu:*

Bulk density was calculated using the following equation:

$$\text{Bulk density (g/ml)} = \frac{\text{Weight (g)}}{\text{Volume (ml)}}$$

Sensory evaluation:

The product *Paddu* was subjected for sensory evaluation using descriptive characteristics by 10 semi trained panel members from the Department of Food Science and Nutrition, Rural Home Science College, UAS, Dharwad for further standardization.

OBSERVATIONS AND ASSESSMENT

For standardization of duration of soaking time, the batter and *Paddus* were prepared by using the pre-standardized proportion of ingredients *i.e.* 6:1 (millet: pulse). The little millet and pulse were soaked separately for 4, 6 and 8 h, respectively.

The batter was allowed to ferment for 12 h. The physical and chemical parameters of batter, physical parameters of *Paddu* and sensory profile are elaborated as follows.

The physical characteristics of little millet *Paddu* batter in relation to soaking are presented in Table 1. It was found that the volume (20 ml) increased to 54.67 ml when the grains were soaked for 4 h. Similarly when the grains were soaked for 6 h, the increase was found to be 56.33 ml. However, when the duration of soaking was increased from 6 to 8 h the increase in the volume reduced (51.33). The increase in volume with increase in the hours of soaking was found to be statistically significant. Similarly the increase in the volume of the batter before and after fermentation with varying hours of soaking was statistically significant ($p<0.01$). This increase in volume of *Paddu* batter is due to incorporation of lactic acid bacteria in the batter during fermentation and entrapment of air. The present finding is similar to that of Gosh and Chattppadhyay (2010).

Further, decrease in the weight of batters was observed after fermentation with increase in the time of soaking. The weight of the batter ranged from 21.47 to 21.69 g. The weight of the batter between soaking time and between fermentation was found to be non-significant. The interaction between soaking and fermentation for weight of the batter was also non significant.

The per cent increase in volume of the batter was significantly higher (181.67 %) for the batter prepared from grains soaked for 6 h when compared to 4 h (173.33%) and 8 h (156.67%) soaking. Significant difference in the per cent increase in volume was observed between duration of soaking and also between before and after fermentation. The interaction between duration of soaking hours and before and after fermentation was significant ($p<0.01$)

The bulk density and specific gravity of little millet batter in relation to soaking is presented in Table 2. When bulk density was calculated taking in to consideration the weight and volume of the batter, it was found that the bulk density of the batters varied with varying time of soaking, however, the differences were non-significant. Before fermentation the bulk density of the batter was 1.08 g/ml. After fermentation the bulk density ranged from 0.38 to 0.42 g/ml. While, the differences in the bulk density of the batters between before and after fermentation with varying time of soaking was statistically highly significant. The specific gravity of the batter ranged from 0.39 to 1.21.

Table 1. Physical characteristics of little millet *Paddu* batter in relation to soaking time

Duration of soaking (h)	Volume (ml)			Weight (g)		
	BF	AF	Mean	BF	AF	Mean
4	20.00	54.67	37.33	21.69	21.61	21.65
6	20.00	56.33	38.17	21.54	21.47	21.50
8	20.00	51.33	35.67	21.58	21.47	21.52
Mean	20.00	54.11	37.06	21.60	21.51	21.56
	S.E.	C.D.			S.E.	C.D.
Soaking (S)	0.87	2.67**			0.17	NS
Between BF and AF (F)	0.71	2.18**			0.14	NS
S x F	0.41	1.26**			0.24	NS

Note : Values are mean of three replications, S.E. - standard error of mean, CD-Critical difference. BF- Before fermentation, AF- After fermentation, **indicates significance of value at P=0.01, NS-Non-significant
S- Soaking, F- Between before and after fermentation S x F = Soaking x Between BF and AF

Table 2. Bulk density and specific gravity of little millet batter in relation to soaking time

Duration of soaking (h)	Bulk density (g/ml)			Specific gravity (g/g)		
	BF	AF	Mean	BF	AF	Mean
4	1.08	0.40	0.74	1.21	0.41	0.81
6	1.08	0.38	0.73	1.20	0.39	0.80
8	1.08	0.42	0.75	1.21	0.42	0.81
Mean	1.08	0.40	0.74	1.21	0.41	0.81
		S.E.	C.D.		S.E.	C.D.
Soaking (S)		0.01	NS		0.009	NS
Between BF and AF (F)		0.01	0.02**		0.007	0.02**
S x F		0.01	NS		0.012	NS

Note : Values are mean of three replications, S.E. - standard error of mean, C.D.-Critical difference. BF- Before fermentation, AF- After fermentation, **indicates significance of value at P=0.01, NS-Non-significant
S- Soaking, F- Between before and after fermentation S x F = Soaking x Between BF and AF

The differences in the specific gravity of the batters between before and after fermentation with varying hours of soaking were found to be significant. The specific gravity of batter between soaking hours was non significant. The interaction between soaking hours and fermentation was non significant for both bulk density and specific gravity. Specific gravity is used as an index to evaluate foam formation of batter that occur during fermentation due to microbial activity. Formation of foam during fermentation is essential in the preparation of *Paddu*, the foam consisted of gas (air) droplets encapsulated by a liquid film containing soluble proteins. Similar results were observed by Kaur *et al.* (2000).

Table 3 depicts the changes in pH and per cent titratable acidity of little millet *Paddu* batters in relation to soaking hours. The pH of the batter of the grains soaked for 4 h which was 6.4 before fermentation reduced to 5.6 after fermentation, while the batters of the grains soaked for 8 h reduced from 6.43 to 5.80. However, the decrease in the pH of the batters with increase in time of soaking of the grains was non significant, while the difference in the pH of the batters between before and after fermentation was highly significant ($p<0.01$).

The data from Table 3 reveal that the per cent titratable of the batters increased from 0.59 to 0.82 for the grains soaked for 4 h and from 0.58 to 0.72 for the grains soaked for 6 h and from 0.59 to 0.78 for the grains soaked for 8 h. However, the increase in the per cent titratable acidity of the batter with increase in the hours of soaking was found to be non-significant. Whereas, the per cent titratable acidity of the batters between before and after fermentation with varying hours of soaking was found to be statistically significant ($p<0.01$). The black gram soaked in water has a high concentration of soluble nutrients to support the growth of lactic acid bacteria. The role of lactic acid bacteria is to reduce pH of the batter to an optimum level (4.4 to 4.5) for yeast activity. The finding is at par with Soni and Sandhu, (1989). The leguminous component of idli batter serves not only as an effective substrate but also provides the maximum number of microorganisms for fermentation. With the fermentation time there is an increase in the per cent total acidity value.

The physical characteristics of little millet *Paddu* in relation to varying soaking hours are presented in Table 4. The number of *Paddus* that could be prepared from soaking the same quantity of grains with varying hours of soaking were same *i.e.* 9 *Paddus*. From the data, it was found that the total weight of *Paddus* prepared from 4 h soaking was more (120.06 g) followed by 6 and 8 h of soaking (119.72 and 114.15), respectively. The total weight of *Paddu* decreased with increase time of soaking of the grains, however, the decrease in total weight of the *Paddu* with varying hours of soaking was non significant.

Further, the total volume of the *Paddus* prepared from 6 h of soaking was more (198.20 ml) followed by 4 h (197.03

Table 3. Changes in pH and per cent titratable acidity of little millet *Paddu* batter in relation to soaking time

Duration of soaking (h)	pH			% titratable acidity		
	BF	AF	Mean	BF	AF	Mean
4	6.40	5.60	6.00	0.59	0.82	0.70
6	6.37	5.73	6.05	0.58	0.72	0.65
8	6.43	5.80	6.12	0.59	0.78	0.68
Mean	6.40	5.71	6.06	0.58	0.77	0.68
	S.E.	C.D.			S.E.	C.D.
Soaking (S)	0.14	NS			0.04	NS
Between BF and AF (F)	0.11	0.35**			0.03	0.09**
S x F	0.19	NS			0.05	NS

Note : Values are mean of three replications, S.E. - standard error of mean, CD-Critical difference. BF- Before fermentation, AF- After fermentation, **indicates significance of value at P=0.01, NS-Non-significant
S- Soaking, F- Between before and after fermentation S x F = Soaking x Between BF and AF

Table 4. Physical characteristics of little millet *Paddu* in relation to soaking time

Duration of soaking (h)	No. of *Paddu*	Total weight of *Paddu* (g)	Total volume of *Paddu* (ml)	Average weight of 1 *Paddu* (g)	Average volume of 1 *Paddu* (ml)	Bulk density of *Paddu* (g/ml)
4	9	120.06	197.03	13.34	21.89	0.61
6	9	119.72	198.20	13.30	22.02	0.60
8	9	114.15	192.77	13.16	22.24	0.59
S.E.	0	4.13	4.69	0.33	0.19	0.02
C.D.	NS	NS	NS	NS	NS	NS

Note: Values are mean of three replications, S.E.-standard error of mean, C.D.-Critical difference. NS-Non-significant

ml) and least was for 8 h of soaking (192.77 ml), however, the difference in the total volume of the *Paddus* in relation to varying hours of soaking was non significant. The average weight of the single *Paddu* was calculated by taking in to consideration the total weight and number of *Paddu*. It was found that the average weight of single *Paddu* prepared with grains soaked for varying hours of soaking ranged from 13.16 to 13.34 g, similarly volume ranged from 21.89 to 22.24 ml, however the differences in the average weight and volume of the *Paddus* in relation to varying time of soaking were non significant. The bulk density of the *Paddu* was calculated by taking in to consideration the weight and volume of *Paddu*, it was found that the bulk density of the *Paddu* varied with varying time of soaking and was non-significant.

The sensory qualities of little millet *Paddu* depict that the texture was hard and bland taste for *Paddu* prepared from grains soaked for 4 h, whereas 8 h soaking affected the taste of the *Paddu* and slight bitterness was felt, the soft texture with acceptable taste was observed in *Paddu* prepared from 6 h soaked grains

Hence, 6 h soaking of grains was considered as optimum condition for little millet *Paddu* preparation. This soaking hours was used for further optimization for fermentation hours.

For standardization of fermentation hours for preparation of little millet *Paddu,* the pre standardized proportion of ingredients *i.e.*, 6:1 and duration of soaking *i.e.*, 6 h was used. The batter was fermented for 8, 10, 12, 14, 16, 18, 20, 22 and 24 h, respectively and *Paddu* were prepared. The physical and chemical characteristics of batter, physical characteristics of *Paddu* and sensory profile of *Paddu* prepared from batter fermented for various duration of hours are discussed below.

Physical characteristics of little millet *Paddu* batter in relation to fermentation are presented in Table 5. From the data, it was found that the initial volume of the batters (20 ml) increased with the increase in fermentation time. The increase in the volume of the batter with varying time of fermentation ranged from 20.47 to 46.67ml, there by the per cent increase in the volume being 2.33 per cent and 133.33 per cent. However, the increase in the volume with increase in the fermentation time was found to be statistically highly significant ($p<0.01$). The increase in the volume of batters between before and after fermentation with varying hours of fermentation was highly significant ($p<0.01$). The interaction between duration of fermentation and before and after fermentation was also significant. Weight of the batters varied with varying hours of fermentation. Before fermentation the weight of batter ranged from 20.19 to 21.97 g whereas after fermentation it ranged from 20.11 to 21.87 g. From the data it was found that the weight of the batter decreased with varying time of fermentation, however, the differences were non significant and the differences in the weight of the batters between before and after fermentation with varying time of fermentation was also non significant. The interaction between duration of fermentation and before and after fermentation was non significant.

Table 6 depicts the bulk density and specific gravity of little millet batter in relation to fermentation. Before fermentation the bulk density of batter ranged from 1.01 to 1.10 g/ml whereas after fermentation the bulk density was reduced and it was in the range of 0.43 to 0.99 g/ml. The bulk density of the batters decreased with increase in the fermentation hours, while the difference were statistically

Table 5. Physical characteristics of little millet *Paddu* batter in relation to fermentation time

Duration of fermentation (h)	Volume (ml)			Weight (g)		
	BF	AF	Mean	BF	AF	Mean
8	20.00	20.47	20.23	20.25	20.19	20.22
10	20.00	27.33	23.67	21.06	20.58	20.82
12	20.00	32.33	26.17	21.64	21.58	21.61
14	20.00	35.67	27.83	21.34	21.56	21.45
16	20.00	37.67	28.83	21.34	21.28	21.31
18	20.00	42.67	31.33	21.33	21.19	21.26
20	20.00	42.67	31.33	20.63	20.52	20.57
22	20.00	45.67	32.83	21.97	21.87	21.92
24	20.00	46.67	33.33	20.19	20.11	20.15
Mean	20.00	36.79	28.39	21.08	20.99	20.04
		S.E.	C.D.		S.E.	C.D.
Fermentation (F)		0.18	0.53**		0.15	0.44**
Between BF and AF		0.26	0.75**		0.07	NS
F x Between BF and AF		0.26	0.75**		0.22	NS

Note: Values are mean of three replications, S.E.-standard error of mean, C.D.-Critical difference. BF- Before fermentation, AF- After fermentation, F- Fermentation, **indicates significance of value at P=0.05, NS= Non-significant

significant ($p<0.01$). The differences in the bulk density of the batters between before and after fermentation with varying hours of fermentation was statistically highly significant ($p<0.01$). Specific gravity of the batter before fermentation varied from 1.04 to 1.13 whereas after fermentation it varied from 0.44 to 1.02, respectively. Specific gravity of the batter varied with varying time of fermentation, while the differences were statistically significant. While the difference in the specific gravity of the batters between before and after fermentation with varying hours of fermentation was found to be highly significant ($p<0.01$). The interaction between duration of fermentation and before and after fermentation was significant for both bulk density and specific gravity of batter. The specific gravity of idli batter decreased with increase in fermentation time. With the increase in the fermentation time the foam stability improved as evidenced by decreased specific gravity of idli batter. This effect on foam stability may be attributed to the effect of pH on net charge and confirmation of proteins (Balasubramanian and Vishwanathan 2007).

Table 7 represents the changes in pH and per cent titratable

Table 6. Bulk density and specific gravity of little millet batter in relation to fermentation time

Duration of fermentation (h)	Bulk density (g/ml)			Specific gravity (g/g)		
	BF	AF	Mean	BF	AF	Mean
8	1.01	0.99	1.00	1.04	1.02	1.03
10	1.03	0.75	0.89	1.06	0.77	0.91
12	1.08	0.67	0.87	1.11	0.73	0.92
14	1.08	0.60	0.84	1.11	0.64	0.88
16	1.07	0.56	0.82	1.09	0.61	0.85
18	1.07	0.50	0.78	1.09	0.50	0.80
20	1.03	0.48	0.76	1.06	0.50	0.78
22	1.10	0.48	0.79	1.13	0.49	0.81
24	1.01	0.43	0.72	1.03	0.44	0.74
Mean	1.05	0.61	0.83	1.08	0.63	0.86
		S.E.	C.D.		S.E.	C.D.
Fermentation (F)		0.007	0.019**		0.01	0.04**
Between BF and AF		0.003	0.009**		0.01	0.02**
F x Between BF and AF		0.009	0.027**		0.04	0.10**

Note: Values are mean of three replications, S.E.-standard error of mean, C.D.-Critical difference. BF- Before fermentation, AF- After fermentation, F- Fermentation, **indicates significant of value at P=0.01, NS= Non-significant.

Table 7. Changes in pH and per cent titratable acidity of little millet *Paddu* batter in relation to fermentation time

Duration of fermentation(h)	pH			% titratable acidity		
	BF	AF	Mean	BF	AF	Mean
8	6.70	6.40	6.55	0.44	0.52	0.48
10	6.70	6.17	6.43	0.45	0.66	0.56
12	6.70	6.03	6.37	0.52	0.92	0.72
14	6.60	5.30	5.95	0.48	0.97	0.73
16	6.67	5.17	5.92	0.47	0.94	0.71
18	6.67	4.77	5.72	0.42	1.03	0.72
20	6.67	4.70	5.68	0.42	1.06	0.74
22	6.67	4.63	5.65	0.42	1.01	0.71
24	6.70	4.53	5.62	0.43	1.01	0.72
Mean	6.67	5.30	5.99	0.45	0.90	0.68
	S.E.	C.D.			S.E.	C.D.
Fermentation (F)	0.05	0.14**			0.009	0.025**
Between BF and AF	0.02	0.07**			0.004	0.012**
F x Between BF and AF	0.07	0.20**			0.012	0.036**

Note: Values are mean of three replications, S.E.-standard error of mean, C.D.-Critical difference. BF- Before fermentation, AF- After Fermentation, F- Fermentation, **indicates significance of value at P=0.01, NS- Non-significant

Table 8. Physical characteristics of little millet *Paddu* in relation to fermentation time

Duration of fermentation (h)	No. of *Paddu*	Total weight of *Paddu* (g)	Total volume of *Paddu* (ml)	Average weight of 1 *Paddu* (g)	Average volume of 1 *Paddu* (ml)	Bulk density of *Paddu* (g/ml)
8	9	126.67	172.67	14.07	19.19	0.73
10	10	131.00	188.00	13.10	18.80	0.70
12	10	117.00	193.67	11.70	19.37	0.60
14	11	128.00	202.67	11.64	18.42	0.63
16	12	134.33	208.67	11.19	17.39	0.64
18	11	133.33	204.67	12.12	18.16	0.65
20	11	133.67	202.33	12.15	18.39	0.66
22	11	135.00	202.33	12.27	18.39	0.67
24	11	134.00	204.33	12.18	18.58	0.66
S.E. $\pm$	0.00	1.21	0.68	0.11	0.07	0.01
C.D. (P=0.01)	0.00**	3.59**	2.04**	0.33**	0.19**	0.02**

Note: Values are mean of three replications, S.E.-standard error of mean, C.D.-Critical difference. **indicates significance of value at P=0.01, NS- Non-significant

acidity of little millet *Paddu* batter in relation to fermentation time. The pH of the batter before fermentation varied from 6.60 to 6.70 and after fermentation ranged from 6.40 to 4.53. pH of the batter after fermentation decreased with the increase in time of fermentation, while the decrease in the pH of fermented batter with varying time of fermentation was found to be significant. Similarly the differences in the pH of the batters between before and after fermentation was highly significant ($p<0.05$). The per cent titratable acidity increased after fermentation with varying time of fermentation. Before fermentation the titratable acidity of the batters ranged from 0.42 to 0.52 per cent and the titratable acidity of the batter after fermentation varied from 0.52 to 1.06 per cent. The increase in per cent titratable acidity with increase in the hours of fermentation was found to be significant. The per cent titratable acidity of the batters between before and after fermentation with varying hours of fermentation was found to be statistically significant ($p<0.01$). There is an increasing trend of acidity level *i.e.*, decrease in the pH value. This is mainly associated with the development of *S. faecalis* producing lactic acid which lowers the pH and production of carbon dioxide, which leavens the batter. The present study is similar to that of Ghosh and Chattropadhay (2010).

The physical characteristics of little millet *Paddu* in relation to varying fermentation time is presented in Table 8. The number of *Paddus* that could be prepared from the same quantity of batter but with varying hours of fermentation varied. The number of *Paddus* that could be obtained with varying time of fermentation was ranged from 9 to 12 *Paddus*. The total weight of the *Paddus* prepared from the batter with varying hours of fermentation ranged from 117.00 to 135.00 g and the differences in the weights in relation to varying hours of fermentation were found to be statistically highly significant ($p<0.01$). The total volume of the *Paddus* prepared from the batter with varying time of fermentation ranged from 172.67 to 208.67 ml while, the differences in the volume with varying hours of fermentation were found to be highly significant. Further the average weight and volume of single *Paddu* prepared from the batter with varying hours of fermentation ranged from 11.19 to 14.07 g and 17.39 to 19.37 ml, respectively, while the differences in the weight and volume with varying hours of fermentation were highly significant ($p<0.01$).

The bulk density of the little millet *Paddu* was calculated by taking in to consideration the weight and volume of the *Paddu*. The bulk density of the *Paddu* prepared from batter fermented for varying time ranged from 0.60 to 0.73, while the difference in the bulk density was highly significant ($p<0.01$). The bulk density decreased as the fermentation time increased. Mukherjee *et al*. (1965) reported that the entrapment of air/gas pockets and the function of microorganisms is responsible for the different functionality of batter bulk density.

The descriptive sensory quality of the little millet *Paddu* in relation to fermentation time revealed that the texture was hard and had a bland taste when prepared from batter fermented for 8 and 10 h and overall acceptability was low. Whereas, the *Paddu* prepared after fermenting the batter for 22 and 24 h had soft texture but because of higher sourness the *Paddu,* it was less acceptable. The *Paddu* prepared from batter fermented for 12 h were having soft texture and slight acidic in taste and had good overall acceptability. The *Paddus* prepared from 14 and 16 h of fermented batter were softer, had good expansion and sour taste, these *Paddu* had higher overall acceptability. *Paddu* prepared from fermenting the batter up to 20 h had also a good overall acceptability. Hence, the ideal duration of fermentation hour for preparation of little millet *Paddu* was 12 to 16 h.

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