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Optimization of processing conditions for improved physical and sensory attributes of little millet (*Panicum miliare*) composite flour bread

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Abstract: Little millet composite bread (30/100 g) was optimized for processing conditions like fermentation time (0, 15, 30, 45 and 60 min), proofing time (45, 60 and 75 min), baking temperature (200 °C, 220 °C, 240 °C and 260 °C) and baking time (10, 12 and 14 min). The optimized bread was evaluated for physical and sensory quality in comparison to wheat and little millet composite bread. Wheat bread showed significantly higher specific volume (3.51cm^3/g) and sensory scores than the little millet composite bread. Little millet composite bread fermented for 15 min (dough), proofed for 75 min and baked at 240°C for 14 min improved the specific volume by 17 per cent than little millet bread prepared as per the standard procedure of wheat bread. Optimization of processing conditions showed significant improvement in the physical and sensory quality of millet bread. Also there was 85 per cent reduction in the fermentation time as compared to standard procedure. The optimized little millet bread was on par with wheat bread for most of the sensory attributes.

Key Words: Composite bread, Little millet, Optimization, Sensory quality

Introduction

Bread consumption and consumer interest for more nutritious bread is increasing all over the world. Composite flour bread is gaining importance owing to its nutritional, therapeutic and nutraceutical properties. Local raw materials substitution for wheat flour is increasing due to the growing market for confectioneries. Thus, several developing countries have encouraged the initiation of programmes to evaluate the feasibility of alternative locally available flours as a substitute for wheat flour (Abdelghafor *et al.,* 2011). Utilization of locally grown cereals in baking industry is an additional advantage for the farmers to have more economic value to crop, better remuneration, value addition and diversified health products. Therefore, the efforts have been made to develop millet composite bread that combine health benefits with good sensorial properties; as millets are good sources of fibre, phytochemicals and micronutrients. Consumption of millet composite breads would be effective in the treatment and prevention of many metabolic disorders. Major problem in the use of composite millet flour in higher quantities in breads is the inferior baking quality as millets do not possess the unique visco-elastic properties of wheat gluten which helps in making breads with high specific volume and soft texture. Acceptable millet breads can be developed with inclusion of millet flour up to 30 to 50 per cent which improves nutritional and health profile (Ballolli *et al.,* 2014 and Mannuramath *et al.,* 2015). Physical and sensory attributes play an important role in promoting millet breads commercially. However, to our knowledge, the effects of optimization of processing conditions on millet composite flour bread quality have not been published before. Hence, the present study was undertaken to optimize little millet flour bread for processing conditions for improved physical, textural and sensory attributes at College of Rural Home Sciences, University of Agricultural Sciences, Dharwad during 2015-16.

Material and methods

Little millet grains and bread making ingredients *viz.*, refined wheat flour (*supermoti*), dry yeast (*Gloripan*), sugar, salt and vegetable oil were purchased from local market. Little millet grains were washed and milled from commercial milling machine and blended at 30 per cent level with refined wheat flour to develop little millet composite flour. For the preparation of wheat bread, 150 g wheat flour, 2.25g dry yeast, 9g sugar, 7.5g oil 2.4g salt and 105±5ml water was used. Yeast was allowed to rise with some amount of sugar in warm water for ten minutes prior to incorporation in the flour. The flour was mixed thoroughly with all the other ingredients. A Kitchen Aid brand kneading machine was used to prepare the dough. The dough was mixed until it leaved the sides of the vessel. The dough was allowed to first proofing in an oil smeared vessel for 2 hr at room temperature and then the dough was separated into parts weighing around 135±3g and kneaded to the cylindrical shape before keeping into the baking bread moulds (12 x 4.5 x 5.5 cm), where the dough was allowed to rest for the second proofing for an hr. The breads were then baked at 220^0 C for 15-20 min till developed colour. The little millet composite flour bread was prepared by replacing refined wheat flour by 30 per cent (Mannuramath *et al.,* 2015). The little millet composite flour bread was optimized for process variables like; fermentation time (0, 15, 30, 45 and 60 min), proofing time (45, 60 and 75 min), baking temperature (200°C, 220°C, 240°C and 260°C) and baking time (10, 12, 14 and 16 min). Little millet breads were studied for physical characteristics like loaf weight, loaf volume and specific volume. Loaf volumes were measured by the rapeseed displacement method. Specific loaf volume was calculated by dividing the loaf volume by the loaf weight by following this formula, loaf volume (cm^3)/loaf weight (g) = cm^3/g. Sensory evaluation of breads was carried out by using nine point hedonic scale by ten trained panel members of Food Science and Nutrition department. The optimized little millet bread was

further evaluated for physical and sensory quality characteristics and compared with wheat bread and little millet bread prepared by using standard procedure. The data was statistically analyzed in SPSS software (version 16.0).

Results and discussion

The optimization of little millet composite flour bread was done for processing conditions like fermentation time, proofing time, baking temperature and baking time. Dough fermentation is the process where yeast starts to convert sugars into carbon dioxide, alcohol and organic acids. Whereas, proofing is the step where gluten network relaxes and become more extensible.

In the present study variation in the fermentation time with constant proofing time and variation in the proofing time with optimized level of fermentation time of dough, exhibited significant variations in the physical characteristics as well as sensory attributes of bread (Table 1 to 3). The increase in the fermentation time of dough from 0 to 60 min, significantly decreased the specific volume and pH of breads from 3.18 to 2.78 cm^3/g and 5.63 to 5.40 respectively (Table 1). The decrease in the pH may be due to increased fermentation rate at early duration, whereas in case of wheat flour it was 2 hr. Similar findings were observed in fermented little millet *Paddu* batter compared to rice (Madalageri and Yenagi, 2015). The better nutrient composition and microflora of the little millet composite flour may be attributed to the early fermentation (Madalageri *et al.,* 2016). The decrease in specific volume may be attributed to the loss of viscoelastic property of gluten. Sapirstein *et al.* (2007) also reported that reduction in the fermentation time from 165 to 90 min and 15 min, resulted in the progressive increase in loaf volume of durum wheat bread. The increase in the proofing time increased the specific volume up to 75 min (3.11 cm^3/g) later the batter was collapsed (Table 1). In case of wheat bread proofing time was 60 min. The early proofing time in wheat bread may be due to the good relaxation of gluten network.

Dough fermentation for 15 min and 75 min proofing was considered as optimal as the bread showed better physical and sensory quality. In the study, fermentation time was significantly reduced from 2 hr to 15 min when compared with the fermentation time of wheat bread. Whereas proofing time was increased from 60 to 75 min compared to wheat bread. These changes may be attributed to the chemical composition and microflora of the flour (Madalageri *et al.,* 2016). The dough fermented for 15 min was considered as optimal condition for composite flour bread, as the sensory scores for taste, texture, flavour and mouth feel were higher than the non fermented dough which exhibited higher specific volume. The highest scores were observed for appearance of bread proofed for 75 min followed by 60 min proofing (Table 3). Bread proofed for 75 min has got highest appearance scores (8.6) followed by 60

Table 1. Specific volume of breads as influenced by variation in different processing conditions

Processing conditions and Specific volume (cm^3/g)*						
Fermentation time	0min	15 min	30 min	45 min	60 min	CD (5%)
Specific volume	$3.18^{a}\pm0.03$	$3.02^{b}\pm0.05$	$2.91^{c}\pm0.05$	$2.81^{d}\pm0.06$	$2.78^{d}\pm0.06$	0.06
pH	$5.63^{a}\pm0.01$	$5.60^{ab}\pm0.02$	$5.57^{bc}\pm0.05$	$5.53^{c}\pm0.06$	$5.40^{d}\pm0.05$	0.08
Proofing time	45 min	60 min	75 min	-	-	-
Specific volume	$2.84^{c}\pm0.04$	$3.04^{b}\pm0.05$	$3.11^{a}\pm 0.03$	-	-	0.05
Baking temperature	200 °C	220 °C	240 °C	260 °C	-	-
Specific volume	$3.15^{a}\pm0.05$	$3.04^{b}\pm0.05$	$2.98^{bc}\pm0.04$	$2.94^{c}\pm0.05$	-	0.06
Baking time	10 min	12 min	14 min		-	-
Specific volume	$2.94^{c}\pm0.04$	$3.00^{b}\pm0.04$	$3.05^{ab}\pm0.02$	-	-	0.06
Specific volume of wheat, little millet composite and optimized little millet bread						
Bread	Specific volume (cm^3/g)@					
Wheat	$3.51^{a}\pm0.04$					
LM 30%	$2.48^{c}\pm0.03$					
Optimized LM	$3.10^{b}\pm0.05$					

LM- Little millet, Mean±SD,

Means with the same superscript letters within a row (*) and column (@) are not significantly different at 5% level

Table 2. Sensory quality of breads as influenced by variation in fermentation time (FT)

FT	Appearance	Crust colour	Crumb colour	Taste	Crust texture	Crumb texture	Flavour	Mouth feel	Overall acceptability
0 min	$8.6^{a}\pm0.70$	$8.5^{a}\pm0.97$	$8.4^{a}\pm0.97$	$8.2^{a}\pm0.79$	$7.3^{b}\pm0.67$	$8.0^{ab}\pm 0.94$	$8.1^{ab}\pm 1.20$	$8.0^{ab}\pm1.15$	$8.4^{a}\pm0.70$
15 min	$8.6^{a}\pm0.84$	$8.5^{a}\pm0.85$	$8.5^{a}\pm0.85$	$8.5^{a}\pm0.70$	$8.3^{a}\pm0.65$	$8.3^{a}\pm1.06$	$8.3^{a}\pm1.05$	$8.4^{a}\pm1.07$	$8.3^{a}\pm0.82$
30 min	$7.8^{b}\pm0.63$	$8.5^{a}\pm0.53$	$8.4^{a}\pm0.52$	$7.4^{b}\pm0.51$	$8.3^{a}\pm1.05$	$8.2^{ab}\pm0.63$	$8.0^{ab}\pm0.47$	$8.3^{a}\pm0.67$	$7.6^{b}\pm0.52$
45 min	$6.9^{c}\pm0.74$	$8.3^{a}\pm0.67$	$8.5^{a}\pm0.71$	$7.1^{b}\pm0.74$	$6.8^{b}\pm0.63$	$7.5^{bc}\pm0.53$	$7.5^{b}\pm0.52$	$7.4^{b}\pm0.70$	$6.5^{c}\pm0.53$
60 min	$6.6^{c}\pm 0.52$	$8.4^{a}\pm0.51$	$8.3^{a}\pm0.67$	$6.4^{c}\pm0.52$	$6.6^{b}\pm0.69$	$7.2^{c}\pm0.79$	$7.4^{b}\pm0.52$	$7.7^{ab}\pm0.48$	$6.3^{c}\pm0.48$
F value	18.04	0.150	0.122	16.29	11.17	3.37	2.30	2.35	24.87
S.Em±	0.22	0.23	0.24	0.21	0.24	0.26	0.25	0.27	0.20
C.D. (5%)	0.63	NS	NS	0.60	0.69	0.73	0.73	0.77	0.56

NS- Non significant, Mean±SD, Means with the same superscript letters within a column are not significantly different at 5% level

Table 3. Sensory quality of breads as influenced by variation in proofing time

Proofing time	Appearance	Crust colour	Crumb colour	Taste	Crust texture	Crumb texture	Flavour	Mouth feel	Overall acceptability
45 min	7.0^{b}±0.82	8.2^{a}±0.63	7.9^{a}±0.88	8.5^{a}±0.53	7.5^{b}±0.85	7.7^{b}±1.06	8.3^{a}±0.48	7.4^{b}±0.52	7.0^{b}±0.47
60 min	8.3^{a}±0.67	8.1^{a}±0.32	8.1^{a}±0.57	8.2^{a}±0.42	8.0^{ab}±0.82	7.9^{ab}±0.74	8.2^{a}±0.79	8.3^{a}±0.82	8.2^{a}±0.63
75 min	8.6^{a}±0.52	8.2^{a}±0.63	8.2^{a}±0.79	8.0^{a}±0.82	8.4^{a}±0.70	8.5^{a}±0.53	8.0^{a}±0.47	8.5^{a}±0.53	8.4^{a}±0.52
F value	22.98	0.111	0.409	1.693	3.249	2.674	0.65	8.427	19.35
S.Em±	0.18	0.17	0.24	0.19	0.25	0.25	0.19	0.20	0.17
C.D. (5%)	0.52	NS	NS	NS	0.72	0.73	NS	0.59	0.50

NS- Non significant, Mean±SD, Means with the same superscript letters within a column are not significantly different at 5% level

min proofed bread (8.3). This is due to increased specific volume at 75 min proofing. Appearance, crust and crumb texture, mouth feel and overall acceptability scores for bread proofed for 75min were significantly higher than the breads proofed for 45 and 60 min. Hence, 75 min proofing was considered as optimal proofing time for composite bread. Flander *et al.* (2007) reported that the final proofing temperature and time as well as intermediate proofing time together with final proofing temperature had significant effects on the hardness of the oat bread.

The standard baking temperature of wheat bread was 220^{0}C and baking time 15 to 20 min or till develops colour. In the present study, variation of baking temperature from 200 to 260^{0}C and baking time from 10 to 14 min for composite bread showed significant effect on specific volume (Table 1). The bread baked at 240^{0}C for 14 min was considered as optimal baking temperature and time because the sensory scores for texture, mouth feel and overall acceptability were higher than other variations (Table 4 and 5). The optimal baking temperature of composite bread was higher than wheat bread. The chemical composition and per cent of damaged starch of flour may contribute for the time variation in the development of crust colour and complete baking of the product. As expected, baking bread at high or low temperature affected the colour and texture of the bread. At high temperature baking, the development of crust colour was early but inside the crumb was not baked properly. Sample which was baked at 260^{o}C was not baked properly hence the sample was rejected. Similar observations were also noted for variation in baking time. Specific volume of breads decreased and ranged from 2.94 to 3.15 cm^{3}/g with increase in the baking temperature. This may be due to early development of crust colour at 240 and 260^{0}C (13 and 11 min respectively) which retained more moisture. Whereas, with increasing baking time from 10 to 14 min, there was significant increase in the specific volume of breads and it was ranged from 2.94 to 3.05 cm^{3}/g (Table 1). Statistically there was no significant change in the sensory scores of breads with varied baking time except the crust colour scores (Table 5). However redness of crust increased with increase in the time of baking which can be explained by declined sensory scores for crust colour and thereby appearance of bread which was baked at 14 min when compared to the 12 min baked bread. Gundu *et al.* (2012) also reported that redness and yellowness (with increase in the a* and b* values) of bread increased with increase in baking time.

Table 4. Sensory quality of breads as influenced by variation in baking temperature

Baking time	Appearance	Crust colour	Crumb colour	Taste	Crust texture	Crumb texture	Flavour	Mouth feel	Overall acceptability
200^{o}C	8.0^{a}±0.82	7.7^{a}±1.06	7.8^{a}±1.03	7.1^{a}±1.29	7.4^{c}±0.97	7.5^{c}±0.85	7.5^{a}±0.71	7.4^{bc}±0.84	7.6^{b}±0.70
220^{o}C	7.9^{a}±0.57	7.5^{a}±0.71	7.7^{a}±0.82	7.2^{a}±1.03	7.9^{bc}±0.57	8.1^{b}±0.74	7.4^{a}±0.84	7.7^{ab}±0.48	7.8^{b}±0.63
240^{o}C	8.0^{a}±0.67	7.6^{a}±1.17	8.1^{a}±0.88	7.6^{a}±0.97	8.3^{ab}±0.48	8.4^{ab}±0.52	7.6^{a}±1.04	8.1^{a}±0.57	8.5^{a}±0.53
260^{o}C	8.1^{a}±0.57	6.8^{a}±0.63	7.5^{a}±0.53	7.1^{a}±0.57	8.6^{a}±0.52	8.8^{a}±0.42	7.4^{a}±0.52	7.0^{c}±0.67	7.9^{b}±0.74
F value	0.130	0.100	0.518	0.574	4.097	4.109	0.127	2.921	5.743
S.Em±	0.16	0.32	0.29	0.35	0.21	0.20	0.28	0.21	0.20
C.D. (5%)	NS	NS	NS	NS	0.60	0.59	NS	0.59	0.57

NS- Non significant, Mean±SD,
Means with the same superscript letters within a column are not significantly different at 5% level

Table 5. Sensory quality of breads as influenced by variation in baking time

Baking time	Appearance	Crust colour	Crumb colour	Taste	Crust texture	Crumb texture	Flavour	Mouth feel	Overall acceptability
10 min	7.4^{a}±0.84	7.9^{b}±0.74	7.6^{a}±0.52	8.0^{a}±0.67	7.8^{a}±0.63	7.8^{a}±0.63	8.1^{a}±0.88	8.2^{a}±0.42	8.1^{a}±0.32
12 min	7.9^{a}±0.99	8.6^{a}±0.52	7.6^{a}±0.84	8.1^{a}±0.91	7.8^{a}±0.91	7.7^{a}±0.48	8.1^{a}±0.57	8.2^{a}±0.79	8.3^{a}±0.67
14 min	7.6^{a}±1.17	8.4^{ab}±0.84	7.7^{a}±0.48	8.1^{a}±0.88	7.7^{a}±0.67	7.8^{a}±0.42	8.1^{a}±0.74	8.3^{a}±0.74	8.2^{a}±0.42
F value	0.617	2.562	0.083	0.045	0.059	0.123	0.001	0.08	0.41
S.Em±	0.32	0.36	0.20	0.27	0.24	0.16	0.23	0.20	0.15
C.D. (5%)	NS	0.65	NS	NS	NS	NS	NS	NS	NS

NS- Non significant, Mean±SD,
Means with the same superscript letters within a column are not significantly different at 5% level

Table 6. Sensory quality of optimized little millet composite flour bread

Breads	Appearance	Crust colour	Crumb colour	Taste	Crust texture	Crumb texture	Flavour	Mouth feel	Overall acceptability
Wheat	8.6^{a} ±0.52	8.6^{a} ±0.51	8.5^{a} ±0.97	8.0^{a} ±0.67	8.4^{a} ±0.52	8.6^{a} ±0.70	8.1^{a} ±0.57	7.5^{b} ±0.52	8.6^{a} ±0.51
LM at 30%	7.6^{b} ±0.52	8.3^{a} ±0.48	7.8^{a} ±0.78	8.0^{a} ±0.82	7.2^{b} ±0.42	6.8^{b} ±0.42	7.9^{a} ±0.56	8.0^{ab} ±0.66	7.0^{b} ±0.67
Optimized LM at 30%	8.0^{b} ±0.74	8.4^{a} ±0.51	8.2^{a} ±0.63	8.1^{a} ±0.74	7.9^{a} ±0.74	8.1^{a} ±0.74	8.2^{a} ±0.63	8.1^{a} ±0.56	8.2^{a} ±0.42
F value	10.05	0.91	1.88	0.06	11.02	21.38	0.67	2.96	23.40
S.Em±	0.15	0.16	0.26	0.23	0.18	0.20	0.13	0.18	0.17
C.D. (5%)	0.46	NS	NS	NS	0.53	0.58	NS	0.54	0.50

NS-Non significant, Mean±SD, LM-Little millet,

Means with the same superscript letters within a column are not significantly different at 5% level

Thus optimized processing conditions for little millet composite bread were 15 min dough fermentation time, 75 min proofing time, 240^{0}C baking temperature and 14 min baking time. Further, optimized little millet bread was compared with wheat bread and little millet composite bread prepared as per the standard procedure of wheat bread for physical and sensory quality. The specific volume of wheat bread was 3.51 cm^{3}/g and it was significantly higher than little millet composite flour breads (Table 1). However, optimized bread had significantly higher specific volume (3.10cm^{3}/g) than the little millet bread. Data of sensory quality of optimized bread (Table 6) showed that optimized bread was on par with wheat bread for most of the sensory attributes and significantly higher scores were seen for texture, mouth feel and overall acceptability than the little millet bread prepared by standard procedure of wheat bread.

Conclusion

From the he study it was concludes that optimization of composite flour bread of little millet for processing conditions like dough fermentation time, proofing time, baking temperature and baking time play a significant role in improving the physical, textural and sensory characteristics of bread. This information is useful for industrial bakers for enhancing the utilization of eco-friendly millets in development of healthy and cost effective products. This is also an advantage for the farmers to have more economic value to their local crop.

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References

Abdelghafor, R. F., Mustafa, A. I., Ibrahim, A. M. H. and Krishnan, P. G., 2011, Quality of bread from composite flour of sorghum and hard white winter wheat. *Adv. J. Food Sci. Technol.,* 3(1): 9-15.

Ballolli, U., Malagi, U., Yenagi, N., Orsat, V. and Gariepy, Y., 2014, Development and quality evaluation of foxtail millet [*Setaria italic* (L.)] incorporated breads. *Karnataka J. Agric. Sci.,* 27(1): 52-55.

Flander, L., Marttila, M. S., Suortti, T. and Autio, K., 2007, Optimization of ingredients and baking process for improved wholemeal oat bread quality, available online at sciencedirect.com*, LWT Food Sci. Technol.,* 40: 860–870.

Gundu, R., Thorat, I. D., Jagtap, D. D., Datta, A. K. and Jayashree, G. C., 2012, Optimization of cup bread baking in household electric oven. *Glo. Adv. Res. J. Food Sci. Technol.,* 1(5): 074-080.

Madalageri, D. and Yenagi, N., 2015, Effect of proportion of ingredients on physico-chemical changes of batter and *Paddu* made of little millet as compared to rice. *Int. J. Farm Sci.,* 5(4): 210-221.

Madalageri, D. M., Yenagi, N. B. and Shirnalli, G., 2016, Evaluation of little millet *Paddu* for physico-chemical nutritional, microbiological and sensory attributes. *Asian J. Dairy Food Res.,* 35(1): 58-64.

Mannuramath, M., Yenagi, N. and Valerie, O., 2015, Quality evaluation of little millet (*Panicum miliare*) incorporated functional bread. *J. Food Sci. Technol.,* 52(12): 8357-8363.

Sapirstein, H. D., David, P., Preston, K. R. and Dexter, J. E., 2007, Durum wheat breadmaking quality: Effects of gluten strength, protein composition, semolina particle size and fermentation time. *J. Cereal Sci.,* 45: 150–161.