Plant Archives **Vol. 25, Special Issue (ICTPAIRS-JAU, Junagadh) Jan. 2025 pp. 790-794**
e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives
Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.SP.ICTPAIRS-113

FORTIFICATION OF COOKIES WITH LITTLE MILLET FLOUR AND JAGGERY

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ABSTRACT

Composite cookies were made from wheat flour blending with little millet flour (LMF) by using jaggery, wheat flour (maida) was mixed with little millet flour at ratios 100:00, 90:10, 80:20, 70:30, 60:40 and 50:50 respectively with jaggery proportion (on flour *w/b* 40%, 50% and 60%). The cookies were evaluated for proximate composition, chemical composition and sensory evaluation score. The proximate composition of composite cookies showed significant increase in moisture, ash, fat and crude fiber whereas decrease in protein and carbohydrates with increase in little millet flour. The substitution of wheat flour (maida) with LMF @ 10, 20, 30, 40 and 50% levels showed increased trend in moisture, ash and crude fiber while carbohydrates and protein content decreased. The Chemical properties of cookies showed that addition of little millet flour significantly improved the dietary fiber, fat and ash of composite cookies. On the basis of sensory evaluation of score, it was noticed that little millet flour incorporated @ 30% level + 70% maida with 50% jaggery in formulation of cookies was found best as compared to standard cookies (100% maida with 50% sugar) with higher overall acceptability.

***Key words*:** Cookies, Fortification, Jaggery, Little millet flour

Introduction

Indian jaggery and khandsari is a traditional sweetener manufactured by unorganized small scale cottage industries from sugarcane, employing more than 2.5 million people in rural areas. Presently, out of the total production of sugarcane about 21.20% is utilized for jaggery and khandsari production at national level. It is an important food for mass consumption since ancient times. The jaggery is an excellent source of essential minerals such as iron, magnesium, phosphorus and zinc. The ancient literature reveals that jaggery and khandsari is a medicinal sweetener, purifies blood, improves digestion and lung health. It is believed that jaggery could be better substitute for white sugar processed by organized mills.

Jaggery production process is labour intensive. Unavailability of labour, their higher wages and increasing process input cost leads to narrow profit margin in jaggery sale. Consequently, jaggery producer are closing their processing plants. Diversion of sugarcane for jaggery and khandsari has reduced from 54.7% to 14.2% during past three decades. Hence, the jaggery and khandsari production has declined from 8.52 million ton in 1980-81 to 4.47 MT in 2012-13. Secondly, per capita consumption of jaggery in the country has shrunk from 12.5 to about 3.7 kg head^{-1} annum^{-1} during three decades (Gangawar *et al*., 2014).

Hence, there urgent need to boost up the jaggery industry and one of the possible ways could be providing technology to produce jaggery based value added nutritious products from small millets.

The small millets are rich in dietary fiber, iron, calcium and B vitamins and contain low phytic acid. Moreover, these millets release sugar slowly in the blood and also diminish the glucose absorption (Gopalan *et al*., 2004). Millets are rich sources of phytochemicals, micronutrients and antioxidants, such as phenolic acids, micronutrients

and glycated flavonoids (Singh *et al*., 2012). Little millet (*Panicum sumatrense*) is rich source in fibre, iron and carotene content. Little millet has a significant role in providing nutrceutical components such as phenols, tannins and phytates along with macro and micro-nutrients (Itagi, 2003). These properties of the small millet made the present consumers attracted to the consumption of millet. Small millets *viz*; Finger millet, Foxtail millet, Barnyard millet, Proso millet, Kodo millet, and little millet, are grown in India over an area of 1.876 million ha with production of 2.4 MT with average productivity of 1286 kg ha^{-1}. To increase the consumption of small millets and to have nutritional security, efforts are being made in terms of value addition through awareness of the nutritional content of all the small millets (Anonymous, 2016).

The development of different jaggery based value added nutritious products from small millets and their commercial availability has become the need of hour to sustain future profitability in the jaggery trade. During recent years, considerable interest has been developed in high protein backed products. Food products like cookies are ready to serve and eat, convenient and reasonable food product and becoming popular among both rural and urban population of India.

Materials and Methods

The laboratory experiment was conducted on utilization of small millets in preparation of jaggery based cookies. The experiment was laid out in Factorial Randomized Block Design with 18 treatment combinations consisting of six proportion of flour blend (Maida : Small millets flour *viz*., 100:00, 90:10, 80:20, 70:30, 60:40 & 50:50) and jaggery proportion (*w/w viz*., 40%, 50% & 60%) and these treatment combinations were compared with the standard cookies (100% maida + sugar). Jaggery based cookies were prepared in the bakery unit of Department of Food Science Technology at Mahatma Phule Krishi Vidyapeeth, Rahuri as per treatments. The composite cookies were prepared using the basic formula developed by Department of Food Science Technology at Mahatma Phule Krishi Vidyapeeth, Rahuri:

Ingredients	Quantity (g)
Blended Flour	1000
Jaggery*	(As per treatments 400, 500 & 600)
Fat	500
Sodium bicarbonate	5
Ammonium bicarbonate	5
Water	As per requirement (approx. 180 to 200 ml)
*Proportionate of Jaggery on flour weight basis: 40%, 50% & 60%.	

Flow chart for preparation of cookies

Blending of Flour (Wheat + Little millet)

⇩

Creaming of veg. Ghee, Jaggery, Salt

⇩

Addition of flour, baking powder and water as required.

⇩

Kneaded to homogenous mass

⇩

Rolling

⇩

Cutting

⇩

Baking (200°C, 20Min)

⇩

Cooling

⇩

Packaging

Analysis of cookies

The cookies were analyzed for moisture, ash, fat, crude fiber, protein and carbohydrates by standard methods (A.O.A.C. 1998).

Statistical analysis

The data obtained for each parameter was subjected to statistical analysis of variance (ANOVA) within the treatments, proportionate of flour blending and proportionate of jaggery and interaction among these parameters. The comparison of means was carried out by Factorial Randomization Block Design (FRBD) as per the methods given by Panse and Sukhatme (1967). The analysis of variance revealed at the significance of S.E and CD at 5% level is mentioned wherever required.

Table 1: Chemical composition (%) of maida, little millet flour (LMF) and jaggery.

Sr. No.	Parameters	Maida	LMF	Jaggery
1	Moisture (%)	11.50	10.83	6.50
2	Ash (%)	1.03	2.90	6.00
3	Fat (%)	1.91	4.92	0.05
4	Protein (%)	12.22	8.66	0.25
5	Crude fiber (%)	0.30	7.73	—
6	Carbohydrates (%)	73.34	65.51	87.5

Table 2: Chemical composition (%) of composite cookies (Maida + LMF + Jaggery).

Treatments	Moisture	Ash	Fat	Protein	Crude fiber	Carbohydrates
Std. Cookies (Control)	**2.02**	**0.56**	**24.86**	**6.39**	**0.16**	**66.01**
Maida: LMF						
A1 (100:00)	2.25	0.60	26.95	6.80	0.17	65.02
A2 (90:10)	3.29	0.69	27.25	6.64	0.58	64.52
A3 (80:20)	3.49	1.04	27.55	6.41	0.99	64.03
A4 (70:30)	3.76	1.09	27.85	6.21	1.41	63.54
A5 (60:40)	4.01	1.20	28.16	6.01	1.82	63.05
A6 (50:50)	4.12	1.36	28.46	5.81	2.23	62.56
SE+	0.01	0.003	0.028	0.04	0.002	0.012
CD at 5%	0.04	0.008	0.081	0.12	0.005	0.036
Jaggery						
B1 (40 %)	3.65	0.81	28.98	6.63	1.26	62.09
B2 (50 %)	3.55	1.00	27.66	6.30	1.20	63.87
B3 (60 %)	3.26	1.19	26.47	6.01	1.14	65.40
SE+	0.01	0.002	0.020	0.03	0.001	0.009
CD at 5%	0.03	0.006	0.057	0.08	0.003	0.025
Interactions						
SE+	0.02	0.005	0.049	0.07	0.003	0.021
CD at 5%	0.07	0.014	NS	NS	0.008	0.062

Results and Discussion

Proximate composition of Little Millet

Proximate compositions of maida, little millet flour (LMF) and jaggery used for the experiment are given Table 1. The little millet flour contains cruder fiber (7.73%) and ash (2.90%) than that of maida. The higher fiber content was due to presence of little millet bran particles present in flour. Similar results were reported by Thilagavathi *et al.*, (2015).

Chemical composition of composite cookies (Maida + LMF + Jaggery)

Table-2a: Interaction effect between Maida + LM flour blend with jaggery proportion on Moisture Content (%) of cookies.

Flour blend (A) / Jaggery Proportion(B)	B1 (40%)	B2 (50%)	B3 (60%)	Mean A
A1 (100:00)	2.42	2.24	2.09	2.25
A2 (90:10)	3.50	3.48	2.90	3.29
A3 (80:20)	3.72	3.68	3.06	3.49
A4 (70:30)	3.82	3.76	3.69	3.76
A5 (60:40)	4.18	4.02	3.82	4.01
A6 (50:50)	4.24	4.12	4.01	4.12
Mean B	3.65	3.55	3.26	
SE+	0.02			
CD at 5%	0.07			

Table-2b: Interaction effect between Maida + LM flour blend with jaggery proportion on Ash content (%) of cookies.

Flour blend (A) / Jaggery Proportion(B)	B1 (40%)	B2 (50%)	B3 (60%)	Mean A
A1 (100:00)	0.35	0.66	0.79	0.60
A2 (90:10)	0.47	0.76	0.84	0.69
A3 (80:20)	0.89	0.97	1.27	1.04
A4 (70:30)	0.95	1.11	1.21	1.09
A5 (60:40)	1.09	1.20	1.32	1.20
A6 (50:50)	1.13	1.28	1.68	1.36
Mean B	0.81	1.00	1.19	
SE+	0.005			
CD at 5%	0.014			

Table-2c: Interaction effect between Maida + LM flour blend with jaggery proportion on Crude Fiber (%) of cookies.

Flour blend (A) / Jaggery Proportion(B)	B1 (40%)	B2 (50%)	B3 (60%)	Mean A
A1 (100:00)	0.18	0.17	0.16	0.17
A2 (90:10)	0.61	0.58	0.55	0.58
A3 (80:20)	1.04	0.99	0.94	0.99
A4 (70:30)	1.48	1.40	1.34	1.41
A5 (60:40)	1.91	1.82	1.73	1.82
A6 (50:50)	2.34	2.23	2.12	2.23
Mean B	1.26	1.20	1.14	
SE+	0.003			
CD at 5%	0.008			

Table-2d: Interaction effect between Maida + LM flour blend with jaggery proportion on Carbohydrate (%) of cookies.

Flour blend (A) / Jaggery Proportion(B)	B1 (40%)	B2 (50%)	B3 (60%)	Mean A
A1 (100:00)	63.80	65.10	66.57	65.02
A2 (90:10)	62.86	64.61	66.10	64.52
A3 (80:20)	62.34	64.12	65.63	64.03
A4 (70:30)	61.83	63.63	65.16	63.54
A5 (60:40)	61.31	63.13	64.70	63.05
A6 (50:50)	60.80	62.65	64.23	62.56
Mean B	62.09	63.87	65.40	
SE+	0.021			
CD at 5%	0.062			

The proximate composition of composite cookies showed significant increase in moisture, ash, fat and crude fiber whereas decrease in protein and carbohydrates with increase in little millet flour (Table 2). The cookies without LMF (100:00) contained 2.25% moisture, 0.60% ash, 26.95% fat, 6.80% protein, 0.17% crude fiber and 65.02%

carbohydrates which was more or less same as that of standard cookies. However, with substitution of wheat maida with LMF @ 10, 20, 30, 40 and 50% levels showed increased trend in moisture, ash, fat and crude fiber and @ 50% level of LMF it was 4.12%, 1.36%, 28.46% and 2.23% respectively while the protein and carbohydrates content lowered down to 5.81% and 62.56%, respectively.

The chemical composition of cookies was found influenced due to increase in proportionate of jaggery levels in cookies. Significant increase in ash (1.19%) and carbohydrates (65.40) whereas significant decrease in moisture (3.26%), fat (26.47), protein (6.01%) and crude fiber (1.14%) content was observed in the composite cookies with 60 % jaggery level.

The interaction effects between maida blending with LMF and jaggery proportion on all chemical properties except protein and fat of composite cookies was found statistically significant (Table 2a to 2d). The highest moisture (4.24%), fat and crude fiber (2.34%) content was noticed in the composite cookies prepared using 50% maida + 50% LMF at 40% jaggery level. However, highest ash content (1.68%) was observed in the composite cookies at 60% jaggery level with same combination of maida and LMF. Highest carbohydrates (66.57%) content was noticed in the cookies of 100% maida which was followed by the composite cookies prepared using 90% maida + 10% LMF (66.10%) at 60% jaggery level.

Table 3: Sensory analysis of composite cookies (Maida + LMF + Jaggery).

Treatments		Colour	Texture	Flavour	Taste	Overall Acceptability
Std. Cookies (Control)		**8.2**	**7.7**	**7.7**	**7.4**	**7.7**
B1 Jaggery 40%	A1 (100:00)	7.8	7.6	7.5	7.5	7.8
	A2 (90:10)	7.5	7.4	7.3	7.0	7.3
	A3 (80:20)	7.8	7.6	7.6	7.8	7.9
	A4 (70:30)	7.6	8.0	7.3	7.7	7.6
	A5 (60:40)	7.2	7.8	7.3	7.6	7.5
	A6 (50:50)	7.4	7.5	7.1	6.7	7.2
B2 Jaggery 50%	A1 (100:00)	7.5	7.2	7.3	7.7	7.4
	A2 (90:10)	7.5	7.5	7.3	7.6	7.5
	A3 (80:20)	7.5	7.5	7.6	7.7	7.7
	A4 (70:30)	8.0	8.0	7.9	8.1	8.3
	A5 (60:40)	7.1	7.3	7.2	7.3	6.8
	A6 (50:50)	6.8	6.6	6.2	6.9	6.6
B3 Jaggery 60%	A1 (100:00)	7.0	7.0	6.9	6.8	7.0
	A2 (90:10)	7.3	6.9	7.0	7.3	7.1
	A3 (80:20)	6.7	6.7	6.7	6.9	6.7
	A4 (70:30)	6.9	7.0	7.2	7.1	6.9
	A5 (60:40)	7.2	6.7	6.8	7.3	6.8
	A6 (50:50)	6.7	6.8	6.7	6.9	6.6

Sensory evaluation of composite cookies (Maida + LMF + Jaggery)

Sensory evaluation of cookies carried out by 9 point hedonic scale from expert panel for colour, texture, flavor, taste and overall acceptability (Table 3). The addition of LMF upto 40% and jaggery levels at 40% and 50% showed at par effect on the sensory characteristics of cookies *i. e.* above 7.0 score. The overall highest acceptability score of cookies with flour combination of maida 70% + LMF 30% and @ 50% jaggery recorded highest score (8.3).

Physical properties of composite cookies (Maida + LMF + Jaggery)

The hardness of cookies was determined by Universal testing machine (Make-Shimadzu, Japan) in terms of breaking force. The breaking force of standard cookies (maida with sugar) was recorded 51.69 N. Due to addition of LMF with jaggery in the preparation of composite cookies, there was increase in breaking force from 51.69 N to 386.12 N. The results revealed that, the best combination of maida with LMF (70:30) @ 50% jaggery

Table 4: Physical properties of composite cookies (Maida + LMF + Jaggery).

Treatments		Colour			Colour Diff.	Breaking (N) Force
Std. Cookies (Control)		***L****	***a****	***b****		
		54.926	**5.126**	**16.468**		**51.693**
B1 Jaggery 40%	A1 (100:00)	55.250	7.92	19.779	4.344	46.85
	A2 (90:10)	57.919	7.147	21.723	6.376	66.15
	A3 (80:20)	55.976	7.994	20.417	4.992	103.81
	A4 (70:30)	56.971	7.18	20.571	5.023	83.89
	A5 (60:40)	57.222	6.262	21.042	5.242	58.85
	A6 (50:50)	57.692	5.147	19.729	4.276	74.53
	Mean	**56.838**	**6.942**	**20.544**	**5.042**	**72.34**
B2 Jaggery 50%	A1 (100:00)	60.777	5.611	23.876	9.452	52.85
	A2 (90:10)	58.012	7.867	22.42	7.243	58.53
	A3 (80:20)	52.863	7.627	22.208	3.708	66.75
	A4 (70:30)	53.230	6.559	18.267	4.131	52.17
	A5 (60:40)	57.339	7.868	19.050	6.689	82.17
	A6 (50:50)	57.586	7.569	20.730	5.224	120.51
	Mean	**56.635**	**7.184**	**21.092**	**6.0745**	**72.16**
B3 Jaggery 60%	A1 (100:00)	49.841	7.307	16.692	5.538	149.56
	A2 (90:10)	51.676	6.939	17.696	3.919	61.55
	A3 (80:20)	56.301	7.177	20.495	4.724	217.44
	A4 (70:30)	57.518	6.136	20.907	5.239	172.20
	A5 (60:40)	55.224	7.738	20.335	4.676	130.92
	A6 (50:50)	44.429	4.694	11.046	11.823	386.12
	Mean	**52.498**	**6.665**	**17.862**	**5.9865**	**186.299**

level recorded the breaking force of cookies 52.17 N, which was at par with the standard cookies. The data regarding effect of LMF and jaggery on the colour values of composite cookies (Table 4) showed that both levels of LMF as well as jaggery affected the colour values *i.e.* *L* *, *a** and *b** of cookies. The colour values of composite cookies *viz.*, *L**, *a** and *b** increased from 54.926 to 60.777, 5.126 to 7.994 and 16.468 to 23.876, respectively. The colour values of cookies may be affected due to the pigments in LMF. It was observed that, the colour values of standard cookies were *L** (54.269), *a**(5.126) and *b**(16.468). The best combination of maida with LMF (70:30) @ 50% jaggery level recorded the colour values of composite cookies were *L** (53.230), *a**(6.559) and *b** (18.267) which was at par with the standard cookies.

Conclusion

Incorporation of little millet flour (LMF) in cookie formulations improved their nutritional profile. The inclusion of LMF enhanced dietary fiber, fat, and ash. Sensory evaluation revealed that the best formulation, containing 30% LMF, 70% maida, and 50% jaggery, was more acceptable than the standard cookie made with 100% maida and 50% sugar. These results suggest that LMF can be a beneficial addition to cookie recipes, enhancing both nutrition and sensory appeal.

Acknowledgement

Authors acknowledge All India Coordinated Research Project on Post-Harvest, Engineering and Technology (AICRP on PHET), ICAR-CIPHET, Ludhiana and Mahatma Phule Krishi Vidyapeeth, Rahuri for financial assistance to conducting the presented research work.

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