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STANDARDIZATION OF A PROTOCOL FOR JAGGERY BASED COMPOSITE COOKIES WITH FINGER MILLET FLOUR

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Abstract: *Composite cookies were made from wheat flour blending with finger millet flour (FMF) by using jaggery. Wheat flour (Maida) was mixed with finger 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% & 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 where as decrease in protein and carbohydrates with increase in finger millet flour. The substitution of wheat flour (maida) with FMF @ 10, 20, 30, 40 and 50 % levels showed increased trend in moisture, ash, crude fiber & carbohydrates and the protein content decreased. The chemical composition of cookies was found influenced due to increase in proportionate of jaggery levels in cookies. The overall acceptability score of cookies with flour combination of 70%maida with 30%FMF by using 50% jaggery w/b recorded highest score (8).*

Chemical properties of cookies showed that addition of finger millet flour significantly improved the crude fiber, fat, ash and carbohydrates of cookies. On the basis of sensory evaluation score, finger millet flour incorporated @ 30 % level + 70 % maida with 50 % jaggery in formulation of cookies was found best as compared to standard cookies.

Key words: *Composite cookies, Finger millet flour, Wheat flour, Maida, Jaggery, Crude fiber, Fat, Ash and Carbohydrates.*

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. 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 tonne in 1980-81 to 4.47 million tonne in 2012-13. Per capita consumption of jaggery in the country has shrunk from 12.5 to about 3.7 Kg/head/annum during three decades (Gangawar et al., 2014). Jaggery 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.

Finger millet (*Eleusinian Caracara)* is an important staple food in the eastern and central Africa as well as some parts of India (Majumder *et al.*, 2006). It is rich in protein, iron, calcium, phosphorous, fiber and vitamin content. The calcium content is higher than all the cereals and iodine content is said to be highest among all the food grains. Finger millet has best quality protein along with the presence of essential amino acid, vitamin A, vitamin B, and phosphorous (Gopalan *et al.*, 2004). Total carbohydrate content of finger millet has been reported to be in the range of 72 to 79.5 % (Pore and Magar, 1979; Joshi and Katoch, 1990; Bhatt et al.,

2003). Joshi and Katoch (1990) reported 3.7% crude fiber in finger millet. The crude fat content in finger millet has been reported in range of 1.3 to 1.8% (Bhatt et al., 2003; Malleshi and Desikachar, 1986; Lupien, 1990). The ash content has been found to be nearly 1.7% (Rao, 1994) to 4.13% (Rao et al., 1973) in finger millet. Thus finger millet is a good source of diet for growing children, expecting women, old age people and patients. It helps to control blood glucose levels in diabetic patients very efficiently. The bulkiness of the fibers and slower digestion rates makes us feel fuller on, fewer calories and therefore may help to prevent eating excess calories (Kang *et al*., 2008). 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 finger millet. With this background, an attempt was made to formulate composite cookies by replacing sugar with jaggery and blending of wheat flour (maida) with finger millet flour.

Materials and Methods

The laboratory experiment was conducted during the year 2016-17 on utilization of finger millet flour 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 (Wheat flour i.e. Maida : Finger millet flour viz., 100:00, 90:10, 80:20, 70:30, 60:40 & 50:50) and jaggery proportion (w/b viz., 40 %, 50 % & 60 %). The standard cookies prepared using 100% maida with sugar was used as control. 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:

Creaming of Veritable Ghee, Jaggery, Sodium bicarbonate & Ammonium bicarbonate

⇩

Mixing

⇩

Addition of water

⇩

Addition of flour (Wheat + Finger millet)

⇩

Kneaded to homogenous mass

⇩

Dough making

⇩

Rolling

⇩

Cutting

⇩

Baking (200 ^{0}C, 15 min)

⇩

Cookies

⇩

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).

Results and Discussion

Proximate composition: Proximate compositions of wheat flour (maida), finger millet flour (FMF) and jaggery used for the experiment are given table 1. The finger millet flour contains more crude fiber (3.62 %), ash (1.76 %), fat (1.98 %), carbohydrates (75.31 %) and less amount of protein (8.52 %) than that of wheat flour (maida). The higher fiber content was due to presence of finger millet bran particles present in flour (Vijaykumar et al., 2013). Ash (6.00 %) and carbohydrates (87.50 %) content in jaggery is higher and lower fat (0.05 %) and protein (0.25 %) content than that of flours (wheat and finger millet).

Chemical composition of composite cookies (Wheat Flour + FMF + Jaggery):

From the table 2, the results revealed that, the chemical composition of composite cookies showed significant increase in moisture (2.13 % to 4.28 %), ash (0.61 % to 1.32 %), fat (26.95 % to 27.00 %) and crude fiber (0.17% to 1.09 %) where as decrease in protein (5.62% to 6.40 %) and carbohydrates (65 % to 65.55 %) with increase in finger millet flour. Higher amount of ash (1.32 %) content was recorded in composite cookies with 50 % maida + 50 % FMF followed by composite cookies with 60 % maida + 40 % FMF (1.16 %) and composite cookies with 70 % maida + 30 % FMF (1.06 %). The cookies without FMF (100 % maida + 0 % FMF) contained 2.13 % moisture, 0.52 % ash, 26.95 % fat, 6.40 % protein, 0.17 % crude fiber and 65.00 % carbohydrates which was more or less same as that of standard cookies. However, with substitution of wheat flour (maida) with FMF @ 10, 20, 30, 40 and 50 % levels showed increased trend in moisture, ash, fat, crude fiber & carbohydrates and @ 50 % level it was 4.28 %, 1.32 %, 27 %, 1.09 % and 65.55 %, respectively while the protein content lowered down to 5.62 % this may be due to the higher percentage of fat, crude fiber and carbohydrate and lower percentage of protein content in finger millet flour as compare to maida.

The chemical composition of cookies was found influenced due to increase in proportionate of jaggery levels in cookies. Significantly increase in ash (1.13 %) and carbohydrates (66.84 %) whereas significantly decrease in moisture (2.91 %), fat (26.08 %), protein (5.71 %) and crude fiber (0.60 %) content was observed in the composite cookies with 60 % jaggery.

The interaction effects between maida blending with FMF and jaggery on all chemical properties except protein, composite cookies were found statistically significant (Table 2a to 2e). The highest moisture (4.89 %), fat (28.27 %) and crude fiber (1.15 %) content was noticed in the composite cookies of 50 % maida + 50 % FMF at 40 % jaggery level. While highest ash (1.65 %), carbohydrates (67.11 %) content in the composite cookies observed at 60 % jaggery level with same combination of maida and FMF.

Sensory evaluation of composite cookies (Maida + FMF + 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 FMF upto 40 % and jaggery levels 40 % and 50 % had at par effect on the sensory characteristics of cookies. The overall

acceptability score of cookies with flour combination of maida 70 % + FMF 30 % and @ 50 % jaggery recorded highest score (8 points).

Physical properties of composite cookies (Maida + FMF + 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 FMF with jaggery in the preparation of composite cookies, there was increase in breaking force from 51.69 N to 131.84 N. The results revealed that, the best combination of maida with FMF (80:20) @ 50 % jaggery level recorded the breaking force of **53.62 N**, which was at par with the standard cookies. The data regarding effect of FMF and jaggery on the colour values of composite cookies (Table 4) showed that both levels of FMF 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 59.269 to 60.993, 6.515 to 7.520 and 18.879 to 22.413 respectively. The colour values of cookies may be affected due to the pigments in FMF. It was observed that, the colour values of standard cookies are L * (59.269), a* (6.515) and b* (18.879). The best combination of maida with FMF (70:30) @ 50% jaggery level recorded the colour values of composite cookies are L * (59.258), a*(6.440) and b*(18.702), which was at par with the standard cookies.

Conclusion

Chemical properties of cookies showed that addition of finger millet flour significantly improved the crude fiber, fat, ash and carbohydrates of cookies. Addition of FMF with jaggery in the preparation of composite cookies, there was increase in breaking force from 51.69 N to 131.84 N. The best combination of maida with FMF (80:20) @ 50% jaggery level recorded the breaking force of **53.62 N**, which was at par with the standard cookies. On the basis of sensory evaluation of score, it was noticed that finger millet flour incorporated @ 30 % level + 70 % maida with 50 % jaggery in formulation of cookies was found best as compared to standard cookies.

Table 1: Chemical composition of maida, finger millet flour (FMF) and jaggery

Sr. No.	Parameters	Maida	FMF	Jaggery
1	Moisture (%)	11.50	8.67	6.50
2	Ash (%)	1.03	1.76	6.00
3	Fat (%)	1.91	1.98	0.05
4	Protein (%)	12.22	8.52	0.25
5	Crude fiber (%)	0.30	3.62	--
6	Carbohydrates (%)	73.34	75.31	87.5

Table2: Chemical composition (%) of composite cookies (Maida + FMF + Jaggery)

Treatments	Moisture	Ash	Fat	Protein	Crude fiber	Carbohydrates
Std. Cookies	2.02	0.56	24.86	6.39	0.16	66.01
Maida:SMF						
A1 (100:00)	2.13	0.52	26.95	6.40	0.17	65.00
A2 (90:10)	2.38	0.61	26.96	6.24	0.35	65.11
A3 (80:20)	2.94	1.02	26.97	6.08	0.54	65.21
A4 (70:30)	3.39	1.06	27.64	5.93	0.72	65.32
A5 (60:40)	3.62	1.16	26.99	5.77	0.91	65.43
A6 (50:50)	4.28	1.32	27.00	5.62	1.09	65.55
SE±	0.03	0.003	0.19	0.06	0.002	0.013
CD at 5%	0.10	0.008	NS	0.17	0.005	0.037
Jaggery						
B1 (40 %)	3.42	0.79	28.25	6.31	0.66	63.64

B2 (50 %)	3.05	0.93	26.93	6.00	0.63	65.32
B3 (60 %)	2.91	1.13	26.08	5.71	0.60	66.84
SE±	0.02	0.002	0.13	0.04	0.001	0.009
CD at 5%	0.07	0.006	0.38	0.12	0.003	0.026
Interaction (AXB)						
SE±	0.06	0.005	0.32	0.10	0.003	0.022
CD at 5%	0.17	0.014	0.92	NS	0.008	0.064

Table 2a: Interaction effect between Maida + FM flour blend with jaggery proportion on moisture content (%) of cookies

Flour blend (A) / Jaggery Proportion(B)	B1	B2	B3	Mean A
A1	2.330	2.160	1.910	**2.133**
A2	2.530	2.360	2.260	**2.383**
A3	3.310	2.800	2.720	**2.943**
A4	3.620	3.340	3.220	**3.393**
A5	3.810	3.540	3.510	**3.620**
A6	4.890	4.080	3.860	**4.277**
Mean B	**3.415**	**3.047**	**2.913**	

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

Flour blend (A) / Jaggery Proportion(B)	B1	B2	B3	Mean A
A1	0.340	0.550	0.680	**0.523**
A2	0.460	0.600	0.760	**0.607**
A3	0.860	0.950	1.240	**1.017**
A4	0.920	1.080	1.180	**1.060**
A5	1.050	1.170	1.270	**1.163**
A6	1.100	1.210	1.650	**1.320**
Mean B	**0.788**	**0.927**	**1.130**	

Table 2 c: Interaction effect between Maida + FM flour blend with jaggery proportion on fat content (%) of cookies

Flour blend (A) / Jaggery Proportion (B)	B1	B2	B3	Mean A
A1	28.230	26.910	25.720	**26.953**
A2	28.240	26.920	25.730	**26.963**
A3	28.250	26.930	25.740	**26.973**
A4	28.250	26.930	27.750	**27.643**
A5	28.260	26.940	25.760	**26.987**
A6	28.270	26.950	25.770	**26.997**
Mean B	**28.250**	**26.930**	**26.078**	

Table 2 d: Interaction effect between Maida + FM flour blend with jaggery proportion on crude fiber (%) of cookies

Flour blend (A) / Jaggery Proportion (B)	B1	B2	B3	Mean A
A1	0.180	0.170	0.160	**0.170**
A2	0.370	0.350	0.330	**0.350**
A3	0.570	0.540	0.510	**0.540**
A4	0.760	0.720	0.690	**0.723**
A5	0.950	0.910	0.860	**0.907**
A6	**1.150**	1.090	1.040	**1.093**
Mean B	**0.663**	**0.630**	**0.598**	

Table2 e: Interaction effect between Maida + FM flour blend with jaggery proportion on Carbohydrate (%) of cookies

Flour blend (A) / Jaggery Proportion (B)	B1	B2	B3	Mean A
A1	63.360	65.050	66.580	**64.997**
A2	63.470	65.160	66.690	**65.107**
A3	63.580	65.270	66.790	**65.213**
A4	63.700	65.380	66.890	**65.323**
A5	63.810	65.480	66.990	**65.427**
A6	63.940	65.600	**67.110**	**65.550**
Mean B	63.643	65.323	66.842	

Table 3: Sensory evaluation of composite cookies (Maida + FMF + Jaggery)

Treatments		Colour	Texture	Flavour	Taste	Overall Acceptability
Std.Cookies (Control)		**8.2**	**7.7**	**7.7**	**7.4**	**7.7**
Jaggery 40%	T1	7.4	7.2	7.4	7.2	7.2
	T2	8.2	7.6	7.4	8.0	7.6
	T3	8.2	7.6	7.8	7.8	7.8
	T4	7.4	7.6	7.4	7.6	7.8
	T5	7.4	6.8	7.0	6.8	6.8
	T6	7.2	7.6	7.0	7.2	7.2
Jaggery 50%	T1	7.2	7.4	6.8	7.4	7.2
	T2	7.8	7.6	7.4	7.6	7.6
	T3	7.6	7.4	7.2	7.8	7.6
	T4	8.0	8.0	7.4	7.6	8.0
	T5	7.0	7	6.6	7.0	6.8
	T6	7.2	7.2	6.4	6.8	6.6
Jaggery 60%	T1	7.4	7.2	7.4	7.8	7.4
	T2	7.6	7.0	7.2	7.4	7.4
	T3	7.4	6.6	7.0	7.2	7.0
	T4	6.6	7.0	6.8	7.0	7.0
	T5	6.8	6.4	6.6	7.0	6.6
	T6	7.0	6.4	6.4	6.6	6.4

Table 4: Physical parameters of composite cookies (Maida + FMF + Jaggery)

Treatment		Colour			Colour Diff	Breaking Force (N)
		L*	a*	b*		
Std. cookies		**59.269**	**6.515**	**18.879**		**51.69**
Jaggery 40%	T1	60.674	6.025	22.413	3.83	99.68
	T2	59.817	7.369	20.427	1.87	97.40
	T3	58.178	6.463	15.655	3.61	106.07
	T4	**59.212**	7.520	**18.795**	1.72	47.70
	T5	58.571	6.823	16.917	2.11	77.60
	T6	59.006	6.154	18.038	1.00	77.09
Mean		**59.243**	**6.726**	**18.707**	**2.36**	**84.26**
Jaggery 50%	T1	59.177	6.883	18.638	2.39	131.84
	T2	58.253	7.423	16.119	3.09	40.54
	T3	58.859	6.634	17.679	2.67	**58.84**
	T4	**59.258**	6.44	18.702	2.69	**53.62**
	T5	58.787	**6.509**	17.449	1.77	69.11
	T6	58.695	6.433	17.185	1.82	85.21
Mean		**58.838**	**6.720**	**17.629**	**2.40**	**79.86**
Jaggery 60%	T1	60.993	7.013	16.618	3.54	122.19
	T2	58.782	7.302	17.615	1.57	85.74
	T3	58.864	6.849	17.782	**1.25**	63.64
	T4	58.659	5.986	17.065	2.05	89.17
	T5	57.514	6.751	13.824	5.36	131.21
	T6	58.698	5.787	17.139	2.17	*
Mean		**58.918**	**6.614**	**16.674**	**2.66**	**81.99**

*** could not break due to stickiness**

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