International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(4): 3639-3642

Received: 12-05-2018
Accepted: 16-06-2018

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Evaluation of maize varieties and their particle size for chapatti making

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Abstract
With passage of time, the demand of gluten free cereals has inclined. Although the maize *chapatti* is traditional product but their preparation challenges has been overlooked till yet. The maize cultivars i.e PMH1, JL3459 and Buland were milled in *attachakki* and their particle size <60, <70 and<80 µm obtained by passing the flour through mesh sieves B1, B2, B3 respectively, and their influence on the composition, pasting properties of flour along with preparation technology and quality of maize *chapatti* was evaluated. ANOVA indicated that chemical composition in terms of protein, fat, ash, reducing sugar, amylose, beta carotene, neutral detergent fiber and acid detergent fiber was differed insignificantly among the various fractions. Pasting data revealed that finest fraction of maize cultivars had highest pasting and final viscosity. The finest fraction of maize cultivar had better preparation ease in regard to dough handling and rollability.

Keywords: maize *chapatti*, particle size, gluten free, maize cultivars

Introduction
Maize is cultivated throughout India. Since miaze is a kharif and zaid crop, thus it can be relied for the availability throughout the year. For breaking the same rotation of crops, promoting diversification, adopting the less irrigated crops, restoring the soil fertility, maize is in demand. Moreover, the government for promoting the cultivation of maize several attempts have been made such as remunerative minimum support price, campaigning with slogan 'Grow more maize inplace of paddy, increase your income and save water. Aside from government initiatives, being food technologist this has duty to resolve preparation technological issues related to the grains. In addition to this, coeliac patients are exclusively dependent on gluten free cereals. Thus the fact also grows interest to stretch research with maize.

Taking all maize products in consideration, maize *chapatti* is one of the important traditional food product, henceforth simple referred as 'Makki ki roti' and along with 'Sarson ka saag' is principal meal of Punjab and mostly relished in winters. Unfortunately, over the time, maize *chapatti* consumption has declined owing to busy lifestyle, professionalism of women, economic considerations and especially because of requiring more skill-full efforts in contrast to wheat *chapatti* which is due absence of gluten protein that contributes binding and elasticity.

Previous studies have widely recognised the effect of particle size and type of varieties of different cereals on chemical composition, processing stages and final quality of products (Gracza and Norris 1961, Sakhare *et al* 2014, Guttieri *et al* 2001, Alsberg and Griffing 1925, Barak *et al* 2012) [8, 17, 9, 3] however, few studies have been reported for gluten free cereals. For instance, effect of maize cultivars and milling methods for maize bread (Brites *et al* 2006) [5], rice flour particle size on its bread (Hera *et al* 2013) [10], maize particle size on physicochemical and rhelogical properties (Hera *et al* 2013) [10], fraction of sorghum flour on gluten free bread (Trappey *et al* 2014). For particular, finer fraction of rice flour ie <75 and < 95 µm gave better bakery products and cupcakes whereas finer fraction (<150µm) gave poor cookie quality (Barak *et al* 2012) [3] studies have been carried out. Thus, the appropriate particle size for maize *chapatti* is needed to be known for corrected its preparation technology.

This study was designed to monitor the effect of maize cultivars and their particle fractions on the chemical composition and pasting properties of flour; *chapatti* making quality and their organoleptic studies.

Material and Methods
Material
Maize varieties namely, PMH1, JL3459 and Buland were procured from Director of seeds, Punjab Agricultural University, Ludhiana.

Methods
Flour preparation
Each maize varieties was milled using mesh sieves B1 (60 µm), B2 (70 µm), B3 (80 µm) in domestic Attahakki (Burr mill). The obtained flour had fractions <60 µm, <70 µm and <80 µm were used for further analysis.

Chemical analysis of flour
The various maize flours maize was analyzed for chemical composition. Standard AACC (2000) [1] procedure was followed for determination of moisture content (44.15 A), protein content (46-11 A), fat (Soxtech apparatus), ash (08-01), crude fibre (Fiber tech) and starch on wet basis.

Pasting behaviour
Flours pasting properties were determined using a Rapid Visco Analyser (RVA) starch master R & D pack V 3.0 (Newport Scientific Narrabeen, Australia) (Batey *et al* 1997). The RVA parameters measured were: peak viscosity (cP), hold viscosity (cP), final viscosity (cP), break down viscosity (cP) and set back viscosity (cP).

Preparation of maize chapatti
The *chapatti* was prepared using the method described by Rao *et al*. (1986) [16]. *Chapatti* of varied particle size flour of each variety was prepared. Standard particle fraction and best cultivars were opted for the incorporation of additives followed by preparation of *chapatti*. Optimum level of water for dough development was recorded. Dough was allowed to rest for 20-30 minutes. Dough ball of 60 g each was sheeted to a circular smooth surface (13.5 cm diameter) with a rolling pin. After that, *chapatti* was backed by occasional turning on hot skillet, until brown spots appeared on it. The puffing and roll-ability attributes were also documented.

Sensory data
The '*chapattis*' were monitored by panel of minimum of ten semi trained judges on nine point hedonic scale in context to appearance, colour, aroma, texture and overall acceptability (Larmond,1970) [14].

Statistical analysis of data
The data collected in different investigations were analysed with factorial design in CRD using software CPCS-1(Gomez and Gomez, 2010) [10].

Results and Discussion
Fractioned flour composition
Influence of fractionation of maize cultivars on milling yield and chemical composition are presented in Table 1. Fractions of maize from <80 to <60 µm caused a decrease in milling yield, PMH1, JL3459 and Buland reduced from 90.28 to 86.80%, 90.96 to 85.32% and 88.60 to 86.87%, respectively. This is probably due to passing of bran through larger sieves which leads to more yield. As can be seen, chemical composition of varied fractions of maize cultivars is recorded in Table 1. Protein content in maize cultivars did not differ significantly among the fractions. Moreover, fractionation of maize cultivars had not significant effect on ash and fat content. Similar results were reported by James *et al* (2013) [11], however Kerr *et al* (1999) [12] and Hera *et al* (2012) observed marginal difference in former attributes, probably due to wide variation in fractions. All cultivars showed an insignificant change in tendency of amylose, reducing sugar and beta carotene among the fractions. For beta carotene, Hera *et al* (2013) [10] supported the stated trend. As bran has coarser fraction and remain intact during milling and is also rich in fiber content might have been responsible for minimal value of fiberin finer fraction as observed in the study. The NDF content ranged from coarser to finer fraction i.e 12.61 to 6.40% in PMH1, 8.44 to 6.79% in JL3459 and 10.43 to 5.28% in Buland, respectively. The data is in agreement with the previous work which revealed that coarser fraction had the highest NDF content (Krishnan *et al* 1986, Ozturk *et al* 2002) [15]. ADF values ranged between 2.60 to 0.55% (PMH1), 4.03 to 1.68% (JL3459) and 5.02 to 2.45% (Buland) for coarser to finest fraction, respectively.

Effect of fractionation on pasting properties of maize flour
The effect of fractionation of flour (<60, <70 and <80 µm) was studied and is tabulated in Table 2. Peak, hold, final, breakdown viscosities were significantly affected with varied particle size fractions. Although the effect of fractionation showed an increase in hold, final, break down and setback viscosities but the trend was not consistent. However, it was seen the finest fraction had higher viscosities than coarser ones. This may be because the smaller particles has more absorption of water contribute lower GT while bigger particles has more chance of starch conversion which lead to lower viscosities (Carvalho *et al* 2010) [6].

Effect of maize variety and their flour particle size on *chapatti* making quality and sensory scores
Quality attributes of maize chapatti in terms of water absorption for dough development; roll-ability and puffing are presented in Table 3. Statistically significant variations were observed in relation to water absorption of varied particle flour (<80, <70, <60 µm) in all maize cultivars. Moreover, in all cultivars as particle size decreases there was increase in water absorption from 119 to 129%, 100 to 130% and 120 to 140% in PMH1, JL3459 and Buland respectively. This fact earlier has been revealed using farinograph (Sakhare *et al.*, 2014; Wang and Flores, 2000) [17, 19]. It has been also claimed that fine corn meal fraction had enhanced water absorption index which would have been responsible for more water absorption during dough development. The finest fraction of flour had optimum roll ability and puffing except Buland. On the basis of preparation and sensory scores, Buland was found to be non-ideal for chapatti preparation. Among the cultivars, Buland achieved least scores; might have been due to highest a* (indicator of redness and greenness) value. Finest fraction *chapatti* awarded highest scores probably due to enhanced water absorption which impart softness and smooth texture. Thus, finest particle fraction (60µ) of PMH1 and JL3459 could be nominated for further studies.

Conclusion
The whole work was carried out with attempts to investigate the influence of fractionation of maize flour into <80, <70 and<60 µm on the physicochemical, pasting properties of flour in addition to chapatti making quality and their sensory scores. Al together the research was conducted with the aim of producing superior maize chapatti with speciality flour. The finest fraction of PMH1 and JL3459 has immense effect

on quality and sensory attributes of chapatti along with insignificant loss of composition of flour. The study revealed that Buland is non-ideal for chapatti preparation due to reddish colour that attributed to non-acceptable appearance. The research would have vast scope to market speciality maize flour (<60µm) for superior and better quality maize chapatti making and have potential to fulfil the real needs of new generation.

Table 1: Milling yield and chemical composition of maize milled flour having varied fractions

Variety	Particle size (µm)	Milling yield (%)	Protein (%)	Fat (%)	Ash (%)	Reducing sugar (g/100g)	Amylose (%)	Beta carotene (µg/g)	NDF (%)	ADF (%)
PMH1	<80	90.28	9.53	4.40	1.28	10.63	22.43	6.22	12.61	2.60
	<70	87.09	9.41	4.36	1.26	10.49	22.36	6.10	9.26	2.37
	<60	86.80	9.37	4.32	1.25	10.44	22.15	6.07	6.40	0.55
CD(0.05)		0.33	NS	NS	NS	NS	NS	NS	0.64	0.88
JL3459	<80	90.96	9.99	4.44	1.20	10.78	21.50	2.90	8.44	4.03
	<70	87.17	9.83	4.37	1.17	10.69	21.19	2.88	7.28	2.26
	<60	85.32	9.69	4.34	1.16	10.47	20.80	2.82	6.79	1.68
CD(0.05)		1.09	NS	NS	NS	NS	NS	NS	0.55	0.39
Buland	<80	88.60	9.14	4.51	1.34	9.65	22.91	6.12	10.43	2.45
	<70	87.60	9.12	4.50	1.34	9.64	22.85	6.09	9.20	2.48
	<60	86.87	9.08	4.44	1.34	9.61	22.89	6.05	5.28	5.02
CD(0.05)		0.87	NS	NS	NS	NS	NS	NS	0.43	1.59

CD: Critical difference at 5% level NS: Non significant NDF: Neutral detergent fibre ADF: Acid detergent fibre

Table 2: Effect of particle size of maize flour on pasting properties

Variety	Particle size (µ)	Peak viscosity (cP)	Hold viscosity (cP)	Final viscosity (cP)	Breakdown viscosity (cP)	Setback viscosity (cP)
PMH1	80	137.67	138.00	254.00	17.00	37.17
	70	149.00	147.00	407.00	1.33	304.00
	60	212.00	145.00	451.33	65.00	263.00
CD(0.05)		3.88	NS	3.89	1.76	4.25
JL3459	80	185.00	184.00	697.00	1.67	513.67
	70	188.00	185.00	544.67	3.33	325.33
	60	487.67	435.00	1037.00	66.00	606.00
CD(0.05)		28.71	4.32	4.83	1.49	63.36
Buland	80	283.00	281.00	661.00	2.67	382.00
	70	375.00	373.33	797.00	4.33	424.00
	60	476.00	397.33	823.67	76.00	422.33
CD(0.05)		5.03	10.68	4.79	2.21	3.12

CD: Critical difference at 5% level

Table 3: Effect of maize variety and flour particle size on quality and sensory attributes of *chapatti*.

Variety	Particle size (µ)	Water absorption (%)	Roll-ability	Puffing	Appearance	Texture	Color	Aroma	Overall acceptability
PMH1	80	119.00	Poor	Poor	8.00	7.33	8.33	8.67	7.08
	70	123.00	Poor	Poor	8.00	8.00	8.33	8.67	7.42
	60	129.00	Fair	Fair	8.00	8.67	8.67	8.67	8.50
CD (0.05)		2.00			NS	0.94	NS	NS	0.75
JL3459	80	100.00	Poor	Poor	8.00	7.00	8.33	8.67	6.75
	70	110.00	Poor	Poor	8.00	8.00	8.00	8.67	7.50
	60	130.00	Fair	Fair	8.00	8.67	8.33	8.67	8.36
CD (0.05)		2.00			NS	0.67	NS	NS	0.43
Buland	80	120.00	Poor	Poor	7.33	6.33	5.00	8.67	5.92
	70	124.00	Poor	Poor	7.33	6.67	5.00	8.67	6.96
	60	140.00	Poor	Poor	7.33	7.67	5.00	8.67	7.33
CD (0.05)		2.00			NS	0.94	NS	NS	0.63

CD = Critical difference at 5% level NS= Non significant

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