International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 8, Issue 36, 2016, pp.-1755-1758.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

# EVALUATION OF MAIZE DHOKLA FOR PHYSICAL, SENSORY AND FUNCTIONAL PARAMETERS

**SHOBHA D.* AND JOSHI NEENA**

Department of Food Science and Nutrition, University of Agricultural Sciences, GKVK, Bengaluru 560 065, Karnataka, India
*Corresponding Author: Email-shobhafsn@gmail.com

Received: April 12, 2016; Revised: April 23, 2016; Accepted: April 24, 2016; Published: September 15, 2016

**Abstract-** Maize has a wide spectrum of non-food uses and there is considerable scope of value addition in terms of novel foods. An attempt was made to prepare maize dhokla (MD)by incorporating maize semolina along with bengal gram dhal. Quality of maize dhokla was assessed for sensory/organoleptic, physical and functional parameters with various levels of maize semolina incorporation (2:1, 3:1 and 4:1). Among various levels of maize semolina incorporation 3:1 (maize semolina: bengal gram dhal) was found to be highly acceptable with an overall acceptability score of 8.35 on a nine point hedonic scale, which was quite comparable to control (8.75). Results of the functional parameters of the best combination revealed that fermentation significantly (P≤0.05) decreased all the functional parameters except titrable acidity and oil absorption capacity. The per cent increase in batter volume was significantly high for maize batter (23.80%) compared to rice batter (17.46%) indicating that the good quality dhokla can be prepared from maize semolina in 3:1 combination.

**Keywords**- Water absorption capacity, Titrable acidity, Swelling capacity, Batter volume, Sensory attributes.

**Citation:** Shobha D. and Joshi Neena, (2016) Evaluation of Maize Dhokla for Physical, Sensory and Functional Parameters. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 8, Issue 36, pp.-1755-1758.



**Academic Editor / Reviewer:** V. Krishnasree, Shukla Ruchira, Savitha Mangannnavar, Rehal Jagbir

## Introduction

Maize (*Zea mays* L.) is known as "Queen of Cereals" because of its highest yield potential and wider adaptability compared to other cereals. After rice and wheat, maize is an important crop in terms of acreage and ranks second in terms of total production and productivity, which accounts for approximately nine per cent of total food grain production in India [1]. Maize is considered poor man's nutricereal for its high content of carbohydrates, proteins, fat and some important vitamins and minerals. Apart from this it has various end uses such as poultry feed (51%), human feed (23%), animal feed (12%), starch (12%) and 1% each for brewery and seed [2]. However, maize is lacking in essential amino acids such as lysine and tryptophan. This can be overcome by the use of QPM (quality protein maize) hybrids as well as combining good quality pulses which suitably make up for individual deficiencies.

Although cereals are treasure house of nutrients, their bioavailability is significantly reduced because of large amounts of anti nutrients (non-nutrients). To enhance the bioavailability of micronutrients in plant-based diets several traditional food-processing and preparation methods can be used at the household level which include thermal processing, mechanical processing, soaking, germination/malting and fermentation.

Indigenous fermented foods, which are strongly linked to our tradition and culture, have been prepared and consumed since age-old days and are good in terms of digestibility, nutritive value as well as bioavailability of nutrients. Fermented foods are prepared by the action of selected microorganisms, which result in biochemically and organoleptically modified substrate producing an acceptable product for human consumption [3].

Fermented foods of cereal and pulse combination constitute an important part of human diet in developing countries such as India. Many fermented foods from rice such as idli, dosa [4] and dhokla [5] are already popular. Dhokla is a lactic acid fermented cake and is prepared from batter of coarsely ground rice and bengal gram dhal which is then fermented, steamed in pie dish cut and seasoned [5]. Fermented foods from maize such as Ogi [6,7] and nixtamalized maize have been standardized and extensively studied by different workers [8-10]. However, fermented foods from maize blended with different pulses and in combination with other cereals like rice are yet to become popular among larger masses. This kind of value addition in maize will offer diversity in food products to the consumers along with improved nutritional quality of this cereal due to fermentation at lower cost. Hence, a study was conducted with an objective to standardize maize dhokla and to evaluate its sensory/organoleptic and physical characteristics.

## Material and Methods

Grains of hybrid maize variety NAH-2049 were procured from the All India Coordinated Research Project on Maize, Zonal Agricultural Research Station (ZARS), V. C. Farm, Mandya and were subjected to treatment with 1% lime solution over night. Later grains were washed with water and sundried to attain a moisture percentage around 9-10 per cent. The grains were dry milled in a mini SS dry grinder mill and passed through 25 BS sieve to get maize semolina of 600 microns. Bengal gram dhal and common salt were purchased from the local market in a single lot and kept in a refrigerator until further use.

For standardization of Dhokla, different levels of maize semolina such as 65 ,75 and 80 per cent were mixed with 35, 25 and 20 per cent bengal gram dhal, respectively to get 2:1, 3:1 and 4:1 cereal : pulse combination. For all the combinations, common salt was added at the rate of 2 per cent. Traditionally Dhokla is prepared with 3:1 combination of rice: bengal gram dhal soaked and as soon as the batter is leavened and acidified batter is steamed and, consumed on t

he same day [4].

Three different combinations of maize semolina: bengal gram dhal (2:1, 3:1, 4:1) and control *i.e.*, rice: bengal gram dhal (3:1) were soaked for 6 hours followed by decanting of soaked water. Bengal gram dhal and rice were ground to fine consistency and mixed with maize semolina to get coarse batter consistency. In case of control, soaked rice and bengal gram dhal were coarsely ground to get batter consistency. Maize batters in three different combinations along with control were kept for fermentation for 14 hrs with the addition of two per cent salt. The fermented batters were added with 0.5 per cent of ginger garlic paste, white pepper powder, steamed in a boiling water pan for 15 minutes, seasoned with mustard, curry and coriander leaves then cutting into square pieces for serving.

**Sensory evaluation**

The products were evaluated by a panel of 21 semi-trained judges, which included the scientific staff of Zonal Agricultural Research Station, V. C. Farm, Mandya. Panelists were provided with coded samples along with a glass of water for rinsing and swallowing between samples. They were given written instructions and allowed to evaluate the products for their acceptability based on appearance, colour, taste, texture and overall acceptability on nine point hedonic scale, where in 9 indicated extreme liking, 8 for very much liking, 7 for moderate liking, 6 for like slightly, 5 for neither like nor dislike, 4 for dislike slightly, 3 for dislike moderately, 2 for dislike very much, and 1 for dislike extremely.

**Descriptive sensory evaluation**

The scorecard was developed for descriptive sensory evaluation. Six expert panelists evaluated four sets of dhokla at separate times for descriptive sensory profile. The panelists were asked to put (✓) mark on the descriptive profile sheet, which described the product best. Best acceptable ratio of the maize incorporation from these two preliminary tests was chosen along with the control for evaluation of functional and batter properties.

**Functional parameters**

Functional property (functionality) is a property of food or food ingredient, besides its nutritional value that affect its utilization [11]. These functional properties include intrinsic physicochemical characteristics like pH, bulk density (BD), titrable acidity, water absorption capacity (WAC), oil absorption capacity (OAC) and swelling capacity (SWC), which may affect the behavior of the food systems during storage. Adequate knowledge of these physicochemical properties reflects on the usefulness and acceptability of food products for human consumption [12].

For the analysis of functional properties the best accepted product from the sensory evaluation was taken along with the control. The fermented samples were dried in a hot air oven at $50^0$ C for 16 hours [13]. Dried samples of both raw (raw ingredients in 3:1 ratio of maize semolina: bengal gram) and fermented ingredients were ground and passed through 60 BS mesh sieve and stored at $4^0$ C until further use. The different functional parameters were assessed based on standard tests. Bulk density was calculated as mass of the flour per unit volume (g/ml) [14] and other properties like water absorption, oil absorption (WAC and OAC) [15], swelling capacity [16] and the pH with the aid of pH meter (Equinox-101) [17] were also measured.

**Batter properties**

Different batter parameters such as initial volume of the batter, final volume of the batter, batter volume increase after fermentation, volume of the batter after expulsion of the gas were recorded [18]. pH of the batter was analyzed by pH meter at the beginning as well as at the end of fermentation. Titrable acidity was calculated [19] where in 5g of the batter was diluted in 10 ml water and titrated against 0.1 N NaOH, and all the analysis were carried out in triplicates.

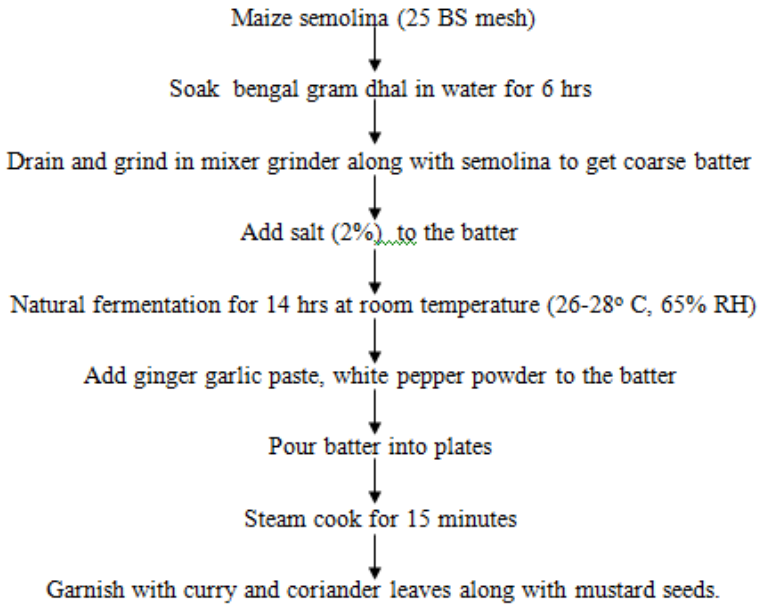
**Statistical analysis**

The data in triplicates was subjected to statistical analysis by Duncan's multiple range tests [20].

**Results and Discussion**

The standardized method of Dhokla preparation is depicted in flow [Chart-1]. The sensory evaluation scores for various levels of maize semolina incorporation [Fig-1]. Significant differences existed among the products with various levels of maize semolina incorporation. Colour of the dhokla varied significantly between control and maize incorporated dhoklas. Maize dhoklas were creamish yellow in colour and were liked very much by the panelists in 3:1 combination compared to control. Even the texture and taste of the 3:1 combination dhokla was 8.75 and 8.6, respectively indicating that this combination was very well accepted in terms of sensory attributes [Fig-1]. The overall acceptability scores of the control (8.75) and maize dhokla (8.35) in 3:1 ratio were found to be significantly superior in sensory evaluation compared to other combinations. The picture of maize and control dhokla in 3:1 ratio clearly depicts their organoleptic acceptability [Fig-2,3].

**Flow chart-1** *Standardised recipe for the preparation of Dhokla*



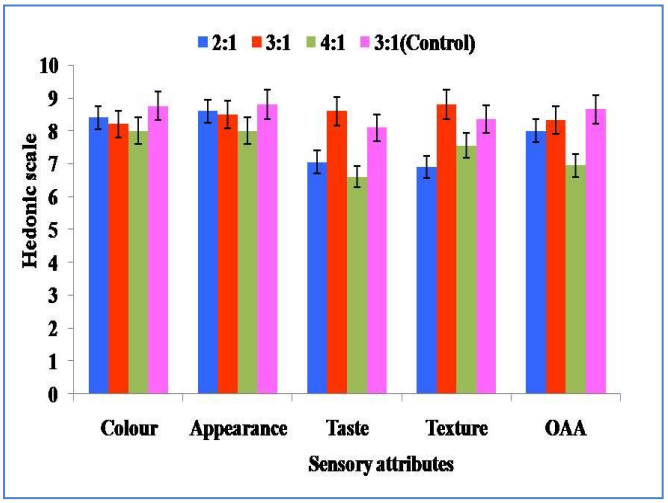



**Fig-1 Sensory attributes of dhokla with various levels of maize semolina incorporation. (2:1, 3:1 & 4:1 are maize semolina: bengal gram dhal. 3:1 control is rice: bengal gram dhal). 9-Point Hedonic scale: 9-like extremely, 8-like very much, 7-like moderately, 6-like slightly, 5-neither like nor dislike, 4-dislike slightly, 3-dislike moderately, 2- dislike very much and 1-dislike extremely.**

**Fig-2 Maize dhokla in 3:1 ratio of maize semolina: bengal gram dhal**

**Fig-3 Rice (control) dhokla in 3:1 ratio of rice: bengal gram dhal**

Descriptive sensory profile of the products is depicted in [Table-1]. The sponginess, aroma and taste scores were found to be appropriate for 3:1 combination followed by 2:1 [Table-1]. None of the combinations exhibited stickiness in dhoklas. The effect of fermentation on the functional parameters is depicted in [Table-2]. The pH of the maize as well as control dhokla was found to decrease with an increase of titrable acidity measured in terms of % lactic acid. This indicated that due to fermentation process pH decreased due to the development of acidity in both the samples [Table-2]. The bulk density values increased after fermentation in both the samples due to entrapment of air, absorption of moisture during fermentation as well as activities of the microorganisms responsible for different functionality after fermentation [21]. Decrease in water and oil absorption capacity after fermentation in both the samples [Table-2] indicated that soaking in water significantly reduced the water and oil absorption capacities in both the samples but the reduction was found to be more pronounced in maize samples. Even the swelling capacity reduced after fermentation in both the samples. Effect of fermentation on physic-chemical properties of some selected cereals revealed decrease in bulk density, water and oil absorption capacity and swelling power as noticed in maize grain with an advancement of fermentation time [22]. Results of Gernah et al. [9] also support decreased swelling capacity and bulk density in fermented maize flour as in the present study, since starches in fermented flours had already been dextrinised and could not swell much. On the contrary, increase in water absorption capacity was reported which was due to increased solubility as a result of increase in soluble sugars present in the fermented flours.

**Table-1** *Descriptive sensory profile of dhokla*

| Descriptive attributes | Maize dhokla | | | Rice dhokla(control) |
|---|---|---|---|---|
| | 2:1 | 3:1 | 4:1 | 3:1 |
| Appearance | Moderately appealing | Moderately appealing | Moderately appealing | Extremely appealing |
| Colour | Light yellow | Moderate yellow | Dark yellow | Typical white |
| Sponginess | Slightly firm | Moderately spongy | Slightly spongy | Moderately spongy |
| Mouthfeel | Not at all Sticky | Not at all Sticky | Not at all Sticky | Not at all Sticky |
| Aroma | Optimally fermented | Optimally fermented | Optimally fermented | Optimally fermented |
| Taste | Typical idli taste | Typical idli taste | Moderately Sour | Typical idli taste |
| Overall acceptability | Extremely acceptable | Extremely acceptable | Moderately acceptable | Extremely acceptable |

2:1, 3:1 & 4:1 are maize semolina: bengal gram dhal, Control (3:1) is rice: bengal gram dhal. (n=6 experts panelists).

Perusal of the [Table-3] revealed the batter characteristics of maize and rice dhokla in 3:1 ratio [Table-3]. The pH of the batter after fermentation was found to decrease significantly with a concomitant increase in the titrable acidity in both the samples. The percentage of increase in batter volume was significantly high for maize batter (23.80 %)compared to rice batter (17.46 %) due to more water uptake by the maize semolina (105 ml per 100 g raw ingredients) compared to control (70 ml per 100 g raw ingredients). However, the decrease in batter volume percentage after fermentation was high for rice batter (42.85 %) compared to maize batter (33.33 %). Similar kind of result was reported for rice idli by Durgadevi and Shetty [19]. The height of maize dhokla after cooking was significantly higher (2.6 cm) compared to rice dhokla (2.0 cm). The nutritional quality of maize dhokla is superior to rice dhokla in terms of protein (11.45%), fat (2.08%) and crude fiber (3.03%) contents [Table-4].

**Table-2** *Effect of fermentation on the functional parameters of dhokla samples*

| | | Raw sample(3:1) | Fermented sample(3:1) |
|---|---|---|---|
| pH | MD | 6.58±0.01[b] | 3.84±0.01[a] |
| | CD | 6.45±0.01[b] | 4.00±0.01[a] |
| Titrable acidity (% lactic acid) | MD | 0.13±0.01[a] | 0.20±0.01[b] |
| | CD | 0.11±0.01[a] | 0.19±0.01[b] |
| Bulk Density (g/cm$^3$) | MD | 0.86±0.01[a] | 0.85±0.01[a] |
| | CD | 0.93±0.01[b] | 0.75±0.02[a] |
| WAC (%) | MD | 180±1.15[b] | 160±0.57[a] |
| | CD | 160±0.57[b] | 145±0.57[a] |
| OAC (%) | MD | 120±1.00[a] | 129.6±1.00[b] |
| | CD | 100±0.57[a] | 106.8±0.57[b] |
| Swelling Capacity (g/g) | MD | 1.30±0.01[a] | 1.01±0.01[a] |
| | CD | 1.32±0.01[b] | 1.04±0.01[a] |

MD: Maize dhokla, CD: Control dhokla, pH-hydrogen ion concentration, WAC-water absorption capacity, OAC-oil absorption capacity. Values are means ± standard deviations (n=3). Data followed by different letters between the rows are significantly different at 5% and the same letters were not significantly different (P<0.05).

**Table-3** *Comparative batter volume characteristics of maize dhokla and rice dhokla*

| | MD batter | CD batter |
|---|---|---|
| Titrable Acidity (before fermentation) (%) | 0.06±0.01[a] | 0.09±0.01[a] |
| Titrable Acidity (after fermentation) (%) | 0.18±0.01[b] | 0.22±0.01[b] |
| pH (before fermentation) | 4.47±0.01[b] | 4.51±0.01[b] |
| pH (after fermentation) | 3.87±0.01[a] | 3.74±0.01[a] |
| Initial volume of the Batter (cm$^3$) | 240±0.35[b] | 200±0.42[a] |
| Final volume of the Batter (cm$^3$) | 315±0.14[a] | 315±0.14[a] |
| Batter volume increased after fermentation (%) | 23.80±0.02[b] | 17.46±0.10[a] |
| Volume of Batter after expulsion of gas (cm$^3$) | 210±0.53[b] | 180±0.69[a] |
| Batter volume decreased after expulsion of gas (%) | 33.33±0.07[a] | 42.85±0.07[b] |
| Height before cooking (cm) | 1.6±0.01[a] | 1.6±0.01[a] |
| Height after cooking (cm) | 2.6±0.02[b] | 2.0±0.01[a] |

MD: maize dhokla, CD: control dhokla Values are mean ± standard deviations. Data followed by different letters are significantly different at 5% and the same letters were not significantly different (P<0.05) (n=3).

**Table-4** *Nutritional comparison between maize and rice (control) dhokla*

| Proximates | Maize dhokla | Rice(control) dhokla |
|---|---|---|
| Protein(%) | 11.45 | 10.71 |
| Fat(%) | 2.08 | 2.02 |
| Ash(%) | 1.37 | 1.62 |
| Crude fiber(%) | 3.03 | 1.02 |
| Carbohyderate(%) | 69.81 | 72.24 |
| Energy( K.Cal) | 351.73 | 358.95 |

**Values are mean of three replications.**

## Conclusion

Dhokla, a traditional fermented product was prepared by incorporating maize semolina and bengal gram dhal in the ratio of 3:1 and fermenting for 14 hours under room temperature. Dhoklas thus prepared were found to be highly acceptable in terms of sensory, functional physical and nutritional attributes.

**Conflict of Interest: None declared**

## References


[1] Anonymous (2014) Indian Maize Summit, pp. 6-14.

[2] Parihar C.M., Jat S.L., Singh A.K., Hooda K.S., Chikkappa G.K., Singh D.K. and Saikumar K. (2011) *Maize production technologies in India*.DMR Technical Bulletin 3. Directorate of Maize Research, Pusa campus, New Delhi 36.

[3] Tamang (1998) *Indian Food Industry*, 17, 162-167.

[4] Sekar and Mariappan (2007) *Indian J. Traditional Knowledge*, 6(1), 111-120.

[5] Ravi U., Lakshmi M. and Anupama M. (2010) *Journal of Scientific and Industrial Research,* 69, 956-960.

[6] Aremu M.O., Olaofe O., Audu S.S. and Ijalana D.M. (2011) *The open nutraceuticals Journal*, 4, 163-171.

[7] Aminigo E.R. and Akingbala J.O. (2004) *Journal of Applied Science and Environment Management,* 8(2), 23-24.

[8] Emmanuel O.A., Philip R.A. and Randy A. (2010) *International Journal of Food Science and Nutrition,* 61(3), 256-271.

[9] Gernah D.I., Ariahu C.C. and Umeh E.U. (2012) *Advanced Journal of Food Science and Technology,* 4(3), 148-154.

[10] Ejigui J., Savoie L., Marin J. and Desrosiers T. (2005) *Journal of Biological Sciences*, 5(5), 590-596.

[11] Pour-ELA (1981) Protein functionality: Classification, definition, and methodology. Page 1 in: Protein functionality in Foods. ASC Symp.Ser. 147. J.P. Cherry, ed. Am. Chem. Soc., Washington, DC.

[12] Shobha D., Dileep Kumar H.V., Sreeramasetty T.A., Puttaramanaik, Pandurange Gowda K.T. and Shivakumar G.B. (2012) *Journal of Food Science and Technology* doi 10.1007/s13197-012-0788-7.

[13] Sokrab A.M, Mohamed Aahmed I.A. and Babiker E.E. (2011) *International Journal of Agricultural Research Reviews*, 1, 38-43.

[14] Okaka J.C. and Potter N.N. (1977) *Journal of Food Science*, 42, 828–833.

[15] Beuchat L.R. (1977) *Journal of Agriculture and Food Chemistry*, 25, 258–261.

[16] Fleming S.E., Sosulski F.W., Filara and Humbert E.S. (1974) *Journal of Food Science*, 39, 188–190.

[17] Samuel S.D., Beatrice C., Esther S.D. and Emmanuel A. (2004) *Food Chemistry*, 86, 317–324.

[18] Durgadevi M. and Shetty P.H. (2014) *Journal of Food Science and Technology*, 51(9), 1773-1783.

[19] Balasubramanian and Viswanathan R. (2006) *Journal of Food Processing and. Preservation*, 31, 32-40.

[20] Duncan D.B. (1955) Multiple range and multiple F test. *Biometrics*, 11, 1-42.

[21] Ghosh D., Chattopadhyay P. (2011) *Food Science and Technology*, 48(5), 610-615.

[22] Alka S., Neelam Y. and Shruti S. (2012) *International Journal of Agriculture and Food Science,* 2(3), 66-70.