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Sensory, Microbial, Texture and Nutritional Evaluation of *Okara* Supplemented Probiotic *Dhokla*

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A B S T R A C T

In the present study *dhokla* was prepared by natural and probiotic (*L. acidophilus*) fermentation with the supplementation of 10, 20 and 30 per cent *okara* powder. Results of organoleptic evaluation indicated that both naturally and probiotic fermented *dhokla* supplemented with 10 per cent *okara* powder were found most acceptable and 'liked moderately' by the judges. Mean scores of all the sensory attributes deceased significantly ($P<0.05$) as the level of *okara* powder supplementation increased from 10 to 30 per cent in both naturally and probiotic fermented *dhokla*. Hardness of both naturally and probiotic fermented *dhokla* increased significantly ($P<0.05$) as the level of *okara* powder supplementation increased from 10 to 30 per cent. The pH of naturally fermented batters of *dhokla* were significantly ($P<0.05$) lower as compared to their respective probiotic fermented counterparts. In both natural and probiotic fermentation, significant ($P<0.05$) difference was observed in between the titratable acidity of without *okara* and with *okara* powder supplemented batters *dhokla*. The counts of lactobacilli i.e. 7.2×10^{10} cfu/ml in control and 6.8×10^{10} cfu/ml in 10 per cent *okara* powder supplemented *dhokla* batters were maximum after 8 h of natural fermentation, followed by yeast cells i.e. 3.3×10^{5} and 3.8×10^{5} cfu/ml in control and 10 per cent *okara* powder supplemented *dhokla* batters, respectively. Whereas, the number of lactobacilli cells increased to 6.1×10^{10} in control and 6.3×10^{10} in *okara* powder (10%) supplemented and probiotic fermented *dhokla* batters after 8 h. A significant ($P<0.05$) decrease was brought about in crude protein, fat and crude fibre contents of naturally and probiotic fermented without *okara dhokla* over unfermented control. Supplementation of 10 per cent *okara* powder in *dhokla* whether fermented naturally or with probiotic microorganism significantly ($P<0.05$) increased the protein, fat, ash and crude fibre content.

Keywords

Soy, *Okara*, *Dhokla*, Sensory, Fermentation, Probiotic, Microbial, Texture, Nutritional

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Introduction

Currently an increase in knowledge of functional foods has led to develop foods with health benefits besides the basic role of nutrition. The traditional fermented foods contain high nutritive value and developed a diversity of flavours, aromas, and textures in food substrates. Now a day, food industries are focusing on different applications of probiotics in food products and creating a new generation of 'probiotic health' foods. Traditionally, probiotic products are usually marketed in the form of fermented milks and yogurts; however, with an increase in vegetarianism amongst consumers throughout developed countries, there is also a demand for vegetarian probiotic products (Ranadheera *et al.,* 2010). The development of non-dairy Probiotic products is a challenge to the food industry in its effort to utilize the abundant natural resources by producing high quality functional products.

Several studies have shown that soy products may be good vehicles for probiotic microorganisms (Bedani *et al.,* 2013; Champagne *et al.,* 2009). The presence of probiotics in commercial food products has been claimed for certain health benefits.

Okara is a by-product with low commercial value generated during the manufacture of soymilk and is potentially a nutritious product high in fiber, protein, carbohydrates, vitamins, minerals and fat and has excellent functional properties (Li *et al.,* 2012).

Since *okara* is a cheap and rich source of good quality protein and dietary fiber, many Asian countries have found a variety of ways to make use of *okara* in many food items such as soups, salads, baked goods and fermented food products such as tempeh (O'Toole, 1999).

Dhokla, a lactic acid fermented product, is originated in Gujarat, India which is mainly consumed as breakfast or snack food having tangy and slightly sweet in taste (Joshi *et al.,* 1989; Roy *et al.,* 2009). However, as it is prepared by using only either rice or semolina and chickpea it is essential to convert the traditional *dhokla* into nutritious *dhokla* with enhanced content of nutrients by value addition, so that, it can be used as functional food in addition to the daily diet.

Therefore, the present study was undertaken to develop probiotic *dhokla* incorporating *okara* and to study their sensory, microbial, textural and nutritional properties.

Materials and Methods

Procurement of material

The grains of soybean (cv. PS 1347) were procured in a single lot from the Department of Genetics and Plant Breeding, College of Agriculture, CCSHAU, Hisar. The seeds were cleaned and made free of dust, dirt and foreign materials and packed in air tight containers for further use. All the ingredients used for *dhokla* preparation were procured from local market. The culture of probiotic microorganism *Lactobacillus acidophilus* was purchased from the Microbial Culture Collection Centre, NDRI, Karnal.

Extraction of *okara*

Okara was extracted as per Chinese method. Soybean seeds were soaked overnight, rinsed and ground in a blender by adding water in 1:8 w/v to obtain the soy slurry; the resultant soy slurry was filtered through double layered cheese cloth. When filteration slowed, the remaining liquid was squeezed out by pressing with the hand for 1-2 min and the residue obtained (called *okara*) was freeze dried, ground to fine powder and stored in air tight polythene sheets for further use.

Development of *dhokla*

Okara based *dhokla* were prepared by supplementing *okara* powder at 10, 20 and 30 per cent levels in bengal gram flour. *Dholka* prepared by bengal gram flour (100%) served as control. For natural fermentation, all the batters of *dhokla* were kept in BOD incubator at 37°C temperature for 8 hours to carry out the fermentation, whereas, for probiotic fermentation, all the batters of *dhokla* were autoclaved at 15 psi for 15 minutes, cooled and then inoculated with probiotic curd containing 10^8 cells/ml and kept in BOD incubator at 37°C temperature for 8 hours. All the *dhokla* batters were steam cooked for 30 minutes in the *dhokla* cooker.

Sensory evaluation of *dhokla*

The developed *dhoklas* were subjected to sensory evaluation with respect to color, appearance, aroma, texture, taste and overall acceptability by a panel of 10 judges using the Nine-point Hedonic Rating Scale.

Texture analysis of *dhokla*

The texture analysis of *dhoklas* was analyzed using texture analyzer TA-HDI (Stable Micro Systems, Surrey, UK). The compression test was used for determination of firmness. The firmness was expressed as peak force (Kg) of the first compression by a pre-set distance (i.e. force taken at 25% compression of 25mm) and expressed as force in Kilograms. The 5 kg compression load cell with 5mm diameter (P/36R) cylindrical probe was used to compress the products. The pre-speed as well as post-speed of the probe was fixed at 1.0mm/s and 10mm/s and the test speed was 1.7mm/s during the compression test.

Determination of titratable acidity and pH of *dhokla* batters

Titratable acidity of fresh batters of the most acceptable *dhokla* before and after fermentation was determined as lactic acid per 100 ml by the method of (AOAC, 2012). The pH of fresh batters of the most acceptable *dhokla* before and after fermentation was measured by a digital pH meter.

Microbial analysis of *dhokla* batters

The fresh batters of the most acceptable *dhokla* before and after fermentation were analyzed for lactobacillus, yeast, fungus and coliform. The batters were serially diluted with normal saline solution individually and appropriate dilutions were pour plated individually using MRS agar (for lactics), YEPDA (for yeasts), PDA (for fungus) and MacConkey's medium (for coliform) plates, incubated at 37°C for 24 h (*Lactobacillus acidophilus*), at 25°C for 72 h (yeast and fungus) and at 30°C for 48 h (coliform). The colonies were counted by pour plating method using a colony counter and results were expressed in terms of cfu /ml of the sample.

Nutritional composition of *dhokla*

The organoleptically most acceptable *dhokla* and their respective unfermented control were oven dried at 55-60°C to a constant weight, ground in an electric grinder (cyclotec, M/S Tecator, Hoganas, Sweden using 0.5 mm sieve size) to a fine powder, stored in air tight polythene sheets and were analyzed for nutritional composition. The moisture, crude protein, crude fat, ash and crude fibre in the samples were estimated by using standard (AOAC, 2012) method. Crude protein was estimated using micro-Kjeldhal method using KEL PLUS Automatic Nitrogen Estimation System and a conversion factor of 6.25 was used to convert nitrogen into protein. Crude fat was determined by the soxhlet extraction method using Automatic SOCS plus Solvent Extraction System.

Crude fibre was estimated by acid and alkaline digestion method using Automatic Fibra plus system. The carbohydrate content was calculated by difference method by subtracting from 100 the sum of the percentage moisture, ash, protein, fat and fibre.

Statistical analysis

The data were statistically analyzed in a completely randomized design using analysis of variance to test the significant differences among treatments (Sheoran and Pannu, 1999).

Results and Discussion

Organoleptic characteristics of *dhokla*

Mean scores of colour, appearance, aroma, texture, taste and overall acceptability of *okara* supplemented *dhokla* are presented in Table 1. The natural and probiotic fermented control *dhokla* containing 100 per cent bengal gram flour had maximum mean scores for colour (8.3 and 8.2), appearance (8.2 and 8.0), aroma (8.1 and 8.0), texture (8.2 and 8.0), taste (8.1 and 8.1) and overall acceptability (8.18 and 8.06) which fell in the category of 'liked very much'. A significant (P<0.05) difference was observed for colour between control and 10 per cent *okara* powder supplemented *dhokla* fermented naturally and with probiotic organism, whereas, appearance, aroma, texture, taste and overall acceptability of naturally and probiotic fermented control and that containing 10 per cent *okara* powder *dhokla* did not differ significantly. Mean scores of all the sensory characteristics i.e. colour (7.8), aroma (7.8 and 7.7), texture (7.7), taste (7.6 and 7.8) and overall acceptability (7.78 and 7.78) of 10 per cent *okara* powder supplemented *dhokla* fermented naturally and with probiotic organism were significantly (P<0.05) higher than supplemented *dhokla* containing 20 and 30 per cent *okara* powder and fell in the category of 'liked moderately'. The appearance of naturally (8.0) and probiotic (7.9) fermented 10 per cent *okara* powder supplemented *dhokla* fell in the category of 'liked very much' and 'liked moderately', respectively. Mean scores of all the sensory attributes deceased significantly (P<0.05) as the level of *okara* powder supplementation in *dhokla* increased from 10 to 30 per cent in both natural and probiotic fermentation. Mean scores of various sensory characteristics of *dhokla* made by supplementation of 20 per cent *okara* powder were 'liked slightly' except taste (5.9) of naturally fermented 20 per cent *okara* powder supplemented *dhokla* which was 'neither liked nor disliked' by the judges. On the other hand, in both natural and probiotic fermentation, the lowest mean scores were observed for 30 per cent *okara* powder supplemented *dhokla* for appearance (6.0 and 6.25) and aroma (6.1 and 6.3) which fell in the category of 'liked slightly', whereas, 'neither liked nor disliked' for texture (5.4 and 5.65), taste (5.0 and 5.4) and overall acceptability (5.68 and 5.96). The colour of naturally (5.9) and probiotic (6.2) fermented 30 per cent *okara* powder supplemented *dhokla* fell in the category of 'neither liked nor disliked' and 'liked slightly', respectively.

For all the sensory characteristics, no significant (P<0.05) differences were observed between the naturally and probiotic fermented *dhokla* supplemented with *okara*. It may be concluded that *dhokla* whether fermented naturally or with probiotic organism and containing 10 per cent level of *okara* powder were found acceptable in terms of their overall acceptability. Gadhe *et al.*, (2010) reported that replacement of bengal gram by soybean in *dhokla* was found acceptable in respect to their sensory characteristics.

Texture analysis of *dhokla*

The data for texture analysis of *dhokla* has been presented in Table 2. Hardness of naturally and probiotic fermented control *dhokla* were 11.25 and 12.62 Newtons, respectively. Naturally (12.78 Newton) and probiotic (14.25 Newton) fermented *dhokla* containing 10 per cent *okara* powder had significantly (P<0.05) more hardness as compared to control *dhokla*. Hardness of both naturally and probiotic fermented *dhokla* increased as the level of *okara* powder supplementation increased from 10 to 30 per cent. Naturally and probiotic fermented *dhokla* containing 30 per cent *okara* powder had significantly (P<0.05) the highest hardness and it was 23.02 and 25.76 Newtons, respectively. Probiotic fermented control and *okara* powder supplemented *dhokla* had significantly (P<0.05) more hardness than those of their respective naturally fermented counterparts.

Table.1 Mean scores of sensory characteristics of *okara* supplemented *dhokla*

Types of *dhokla*	Types of fermentation		Mean	Types of fermentation		Mean
	Natural	Probiotic		Natural	Probiotic	
	Colour			Appearance		
Control Bengal gram flour (100%)	8.3±0.15	8.2±0.20	**8.25**	8.2±0.13	8.0±0.21	**8.10**
Type-I Bengal gram flour:*Okara* powder (90:10)	7.8±0.13	7.8±0.20	**7.80**	8.0±0.21	7.9±0.23	**7.95**
Type-II Bengal gram flour:*Okara* powder (80:20)	6.9±0.10	6.7±0.15	**6.80**	6.7±0.34	6.85±0.21	**6.78**
Type-III Bengal gram flour:*Okara* powder (70:30)	5.9±0.31	6.2±0.25	**6.05**	6.0±0.33	6.25±0.34	**6.13**
Mean	**7.23**	**7.23**		**7.23**	**7.25**	
CD (P≤0.05)	Type 0.40 Treatment NS Interaction NS			Type 0.52 Treatment NS Interaction NS		
	Aroma			Texture		
Control Bengal gram flour (100%)	8.1±0.10	8.0±0.16	**8.05**	8.2±0.13	8.0±0.15	**8.10**
Type-I Bengal gram flour:*Okara* powder (90:10)	7.8±0.13	7.7±0.17	**7.75**	7.7±0.21	7.7±0.21	**7.70**
Type-II Bengal gram flour:*Okara* powder (80:20)	6.5±0.37	6.7±0.21	**6.60**	6.2±0.29	6.4±0.22	**6.30**
Type-III Bengal gram flour:*Okara* powder (70:30)	6.1±0.43	6.3±0.21	**6.20**	5.4±0.52	5.65±0.32	**5.53**
Mean	**7.13**	**7.18**		**6.88**	**6.94**	
CD (P≤0.05)	Type 0.55 Treatment NS Interaction NS			Type 0.56 Treatment NS Interaction NS		
	Taste			Overall acceptability		
Control Bengal gram flour (100%)	8.1±0.10	8.1±0.23	**8.10**	8.18±0.08	8.06±0.17	**8.12**
Type-I Bengal gram flour:*Okara* powder (90:10)	7.6±0.22	7.8±0.33	**7.70**	7.78±0.14	7.78±0.20	**7.78**
Type-II Bengal gram flour:*Okara* powder (80:20)	5.9±0.38	6.2±0.20	**6.08**	6.45±0.27	6.57±0.14	**6.51**
Type-III Bengal gram flour:*Okara* powder (70:30)	5.0±0.52	5.4±0.31	**5.20**	5.68±0.39	5.96±0.29	**5.82**
Mean	**6.66**	**6.88**		**7.02**	**7.09**	
CD (P≤0.05)	Type 0.62 Treatment NS Interaction NS			Type 0.48 Treatment NS Interaction NS		

Values are mean ± SE of ten independent determinations

Table.2 Texture analysis (Newtons) of *dhokla*

Types of *dhokla*	Types of fermentation		Mean
	Natural fermentation	Probiotic fermentation	
Control Bengal gram flour (100%)	11.25±0.18	12.62±0.60	**11.93**
Type-I Bengal gram flour:*Okara* powder (90:10)	12.78±0.61	14.25±0.42	**13.52**
Type-II Bengal gram flour:*Okara* powder (80:20)	17.65±1.28	20.06±0.64	**18.86**
Type-III Bengal gram flour:*Okara* powder (70:30)	23.02±0.46	25.76±0.55	**24.39**
Mean	**16.18**	**18.17**	
CD (P≤0.05)	Type 1.40 Treatment 0.99 Interaction NS		

Values are mean ± SE of three independent determinations

Table.3 Effect of fermentation on pH and titratable acidity (% lactic acid) of *dhokla* batters

Types of *dhokla* batters	pH	Titratable acidity
Bengal gram flour (100%) Unfermented Control	5.28±0.02	0.28±0.04
Natural fermentation		
Bengal gram flour:*Okara* powder (100:0)	4.70±0.02	0.85±0.02
Bengal gram flour:*Okara* powder (90:10)	4.66±0.02	0.94±0.01
Probiotic fermentation		
Bengal gram flour:*Okara* powder (100:0)	4.84±0.01	0.62±0.02
Bengal gram flour:*Okara* powder (90:10)	4.72±0.01	0.78±0.03
CD (P≤0.05)	0.05	0.08

Values are mean ± SE of three independent determinations

Table.4 Effect of fermentation on microbial count of *dhokla* batters (cfu/ml)

Organism	Period of fermentation (hour)	Types of fermentation			
		Natural fermentation		Probiotic fermentation	
		Control Bengal gram flour (100%)	Bengal gram flour: *Okara* powder (90:10)	Control Bengal gram flour (100%)	Bengal gram flour: *Okara* powder (90:10)
Lacto bacillus	0	4.8×10^{6}	3.6×10^{6}	-	-
	8	7.2×10^{10}	6.8×10^{10}	6.1×10^{10}	6.3×10^{10}
Yeast	0	3.1×10^{4}	3.3×10^{4}	-	-
	8	3.3×10^{5}	3.8×10^{5}	-	-
Coliform	0	2.0×10^{2}	1.7×10^{2}	-	-
	8	2.5×10^{3}	2.1×10^{3}	-	-
Fungus	0	-	-	-	-
	8	-	-	-	-

Values are mean of three independent determinations

Table.5 Effect of fermentation on nutrient composition of *dhokla* (g/100 g, dry weight basis)

Types of *dhokla*	Moisture	Crude protein	Fat	Ash	Crude fiber	Carbohydrate
Bengal gram flour (100%) Unfermented Control	3.80±0.09	20.56±0.25	5.32±0.07	4.84±0.08	3.35±0.04	62.13±0.43
Natural fermentation						
Bengal gram flour:*Okara* powder (100:0)	3.93±0.04	16.33±0.38 (-20.57)	3.84±0.02 (-27.82)	4.63±0.04	2.85±0.03 (-14.93)	68.42±0.35 (+10.12)
Bengal gram flour:*Okara* powder (90:10)	4.11±0.04	17.21±0.29 (-16.29)	4.42±0.06 (-16.92)	4.52±0.13	4.54±0.07 (+35.52)	65.20±0.38 (+4.94)
Probiotic fermentation						
Bengal gram flour:*Okara* powder (100:0)	3.87±0.10	16.48±0.64 (-19.84)	3.90±0.04 (-26.69)	4.75±0.06	2.78±0.09 (-17.01)	68.23±0.78 (+9.82)
Bengal gram flour:*Okara* powder (90:10)	3.97±0.05	17.35±0.64 (-15.61)	4.50±0.05 (-15.41)	4.62±0.06	4.50±0.06 (+34.33)	65.05±0.62 (+4.70)
CD (P≤0.05)	NS	1.06	0.17	NS	0.19	1.72

Values are mean ± SE of three independent determinations
Values in parentheses indicate per cent increase/decrease over unfermented without *okara* control

Effect of fermentation on pH and titratable acidity of *dhokla* batters

The data pertaining to the effect of fermentation on pH and titratable acidity of *dhokla* batters is presented in Table 3. The unfermented control *dhokla* containing 100 per cent bengal gram flour had 5.28 pH and 0.28 per cent titratable acidity. The pH of naturally (4.70 and 4.66) and probiotic (4.84 and 4.72) fermented without *okara* and 10 per cent *okara* powder supplemented *dhokla* batters decreased significantly (P<0.05) over the unfermented control, respectively. The pH of naturally fermented without *okara* and 10 per cent *okara* powder supplemented *dhokla* batters were significantly (P<0.05) less as compared to their respective probiotic fermented counterparts. No significant difference was observed between without *okara* and 10 per cent *okara* powder supplemented *dhokla* batters when fermented naturally, whereas, it differed significantly (P<0.05) when fermented with probiotic organism. The titratable acidity of naturally (0.85 and 0.94%) and probiotic (0.62 and 0.78%) fermented *dhokla* batters without *okara* and 10 per cent *okara* powder increased significantly (P<0.05) over the unfermented control. The titratable acidity of naturally fermented *dhokla* batters without *okara* and 10 per cent *okara* powder were significantly (P<0.05) higher than those of their respective probiotic fermented counterparts. A significant (P<0.05) difference was observed in the titratable acidity of *dhokla* batters without *okara* and containing 10 per cent *okara* powder when subjected to both natural and probiotic fermentation. Similar drop in pH and increase in titratable acidity was reported in *dhokla* by various workers (Roy *et al.*, 2007; Gadhe *et al.*, 2010; Patel *et al.*, 2013; Lai, 2014).

Effect of fermentation on microbial count of *dhokla* batters

The data regarding the effect of fermentation on microbial count of *dhokla* batters is given in Table 4. The counts of lactobacillus (4.8×10^6 cfu/ml) and yeast (3.1×10^4 cfu/ml) present naturally in control and 10 per cent *okara* powder supplemented (3.6×10^6 cfu/ml lactobacilli and 3.3×10^4 cfu/ml yeast) *dhokla* batters showed a progressive increase in their numbers after fermentation for 8 h. After 8 h of natural fermentation, the maximum increase in cell number was observed for lactobacilli i.e. 7.2×10^{10} cfu/ml in control and 6.8×10^{10} cfu/ml in 10 per cent *okara* powder supplemented *dhokla* batters followed by yeast cells i. e. 3.3×10^5 and 3.8×10^5 cfu/ml in control and 10 per cent *okara* powder supplemented *dhokla* batters, respectively.

The number of coliforms increased from 2.0×10^2 to 2.5×10^3 and 1.7×10^2 to 2.1×10^3 in control and 10 per cent *okara* powder supplemented and naturally fermented *dhokla* batters. Fungus cells were not found in any of the *dhokla* batters. Upon 8 h probiotic fermentation, the number of lactobacillus cells increased to 6.1×10^{10} in control and 6.3×10^{10} in *okara* powder (10%) supplemented and probiotic fermented *dhokla* batters. Increase in microbial count of *dhokla* was reported by Joshi *et al.*, (1989) and Gadhe *et al.*, (2010) too.

Effect of fermentation on nutrient composition of *dhokla*

The data regarding effect of fermentation on nutrient composition of *dhokla* has been presented in Table 5. The moisture contents of naturally (3.93 and 4.11 g/100 g) and probiotic (3.87 and 3.97 g/100 g) fermented without *okara* and 10 per cent *okara* powder supplemented *dhokla* were almost similar to that of unfermented without *okara* control (3.80 g/100 g) *dhokla*. Moisture contents of present study were in the range of those reported by Bhama *et al.*, (2006). The crude protein content of unfermented without *okara* control *dhokla* was 20.56 g/100 g which decreased significantly ($P<0.05$) after natural (16.33 g/100 g) and probiotic (16.48 g/100 g) fermentation i.e. 20.57 and 19.84 per cent, respectively over the unfermented control *dhokla*. Also, the protein contents of naturally (17.21 g/100 g) and probiotic (17.35 g/100 g) fermented containing 10 per cent *okara* powder *dhokla* were significantly ($P<0.05$) reduced i.e. by 16.29 and 15.61 per cent over the unfermented without *okara* control *dhokla*. Similarly, significant decrease in protein content after fermentation was reported by Sindhu and Khetarpaul (2005) in single and sequential cuture culture fermentation of cereal and pulse food mixtures and Arora *et al.*, (2010) for *L. acidophilus* fermentation of barley food mixture. In both naturally and probiotic fermented *dhokla* prepared by supplementation of 10 per cent *okara* powder in it had significantly ($P<0.05$) more protein content than that observed in without *okara dhokla*. Similar protein content was reported by Bhama *et al.*, (2006) and Gadhe *et al.*, (2010) for control *dhokla*. The fat content of naturally (3.84 g/100 g) and probiotic (3.90 g/100 g) fermented *dhokla* without *okara* decreased significantly ($P<0.05$) over the unfermented without *okara* control (5.32 g/100 g) *dhokla*. Similarly, a significant ($P<0.05$) decrease was observed in the fat content of 10 per cent *okara* powder supplemented *dhokla* fermented naturally (4.42 g/100 g) and with probiotic (4.50 g/100 g) organism over the unfermented control *dhokla*. A significant ($P<0.05$) decrease was observed in both natural and probiotic fermented without *okara* (27.82 and 26.69%) as well as 10 per cent *okara* powder supplemented (16.92 and 15.41%) *dhokla*. The fat contents of both naturally and probiotic fermented *dhokla* having

10 per cent *okara* powder were significantly (P<0.05) more than that of naturally and probiotic fermented *dhoklas* without *okara*. Decrease in fat content may be attributed to the breakdown of fatty acid and glycerol by lipolytic organism present in the sample during fermentation. The decrease in fat content was also reported earlier by Ojokoh and Bello (2014) in soybean and Marko *et al.*, (2014) in cereals. Bhama *et al.*, (2006) reported higher values for fat content of control *dhokla* than that found in present study. The ash contents of naturally (4.63 and 4.52 g/100 g) and probiotic (4.75 and 4.62 g/100 g) fermented *dhokla* without *okara* and 10 per cent *okara* powder supplementation were statistically almost similar to that of unfermented without *okara* control (4.84 g/100 g) *dhokla*. The results found in present study for control *dhokla* are on the similar lines as those reported previously by Bhama *et al.*, (2006), whereas, Kalaiyarasi and Kaimathi (2014) reported lower values for ash content of *dhokla*. The crude fibre content of naturally (2.85 g/100 g) and probiotic (2.78 g/100 g) fermented *dhokla* without *okara* decreased significantly (P<0.05) i.e. 14.93 and 17.01 per cent over the unfermented without *okara* control (3.35 g/100 g) *dhokla*. The crude fibre content was 4.54 g/100 g in naturally and 4.50 g/100 g in probiotic fermented and 10 per cent *okara* powder supplemented *dhokla*. Supplementation of 10 per cent *okara* powder in *dhokla* significantly (P<0.05) increased the crude fibre content of naturally (35.52%) as well as probiotic (34.33%) fermented *dhokla* over the unfermented without *okara* control *dhokla*. Bhama *et al.*, (2006) reported lower values for crude fibre content in *dhokla*. The carbohydrates content of unfermented without *okara* control *dhokla* was 62.13 g/100 g and it increased significantly (P<0.05) in naturally (68.42 g/100 g) and probiotic (68.23 g/100 g) fermented without *okara dhokla* i.e. 10.12 and 9.82 per cent, respectively over the unfermented without *okara* control *dhokla*. The carbohydrate content in naturally and probiotic fermented *dhoklas* which contained 10 per cent *okara* powder were 65.20 and 65.05 g/100 g, respectively, and were significantly (P<0.05) increased to 4.94 and 4.70 per cent, respectively over the unfermented without *okara* control *dhokla*. Similar range for carbohydrate contents in control *dhokla* were reported by Bhama *et al.*, (2006) and Gadhe *et al.*, (2010).

It may be concluded from the present study that development of value added probiotic *dhokla* by incorporating *okara* is not only organoleptically acceptable but also nutritionally rich and explores the possibility of utilizing this valuable byproduct which is rich in protein, fibre, minerals and antioxidants and consumption of such products can serve as functional foods with health potential.

References

AOAC. 2012. Official Methods of Analysis, 19th edition. *Association of the Official Analytical Chemists,* Washington D.C, USA.

Arora, S., Jood, S. and Khetarpaul, N. 2010. Effect of germination and probiotic fermentation on nutrient composition of barley based food mixtures. Food Chemistry. 119: 779-784.

Bedani, R., Rossi, E.A., and Saad, S.M.I. 2013. Impact of inulin and *okara* on *Lactobacillus acidophilus* La-5 and *Bifidobacterium animalis* Bb-12 viability in a fermented soy product and probiotic survival under *in vitro* simulated gastrointestinal conditions. Food Microbiology. 34: 382-389.

Bhama, S., Sadana, B.K. and Malhotra, S.R. 2006. Mineral availability of chickpea (*Cicer arietinum*) processed products. Beverage and Food World. 4: 60-62.

Champagne, C.P., Green-Johnson, J.M., Raymond, Y., Barrette, J. and Buckley, N.D. 2009. Selection of probiotic bacteria for the fermentation of a soy beverage in combination with *Streptococcus thermophilus*. Food Research International. 42(5-6): 612-621.

Gadhe, K.S., Jadhav, B.A. and Kshirsagar, R.B. 2010. Utilization of soyabean in *dhokla* preparation. Bioinfolet. 7(4): 309-312.

Joshi, N., Godbole, S.H. and Kanekar, P. 1989. Microbiological and biochemical changes during *dhokla* fermentation with special reference to flavor compounds. Journal of Food Science and Technology. 26: 113-115.

Kalaiyarasi, C. and Kalaimathi, J. 2014. Preparation of fermented foods-t*ofu* and d*hokla* and bio evaluating its nutritional and sensory properties. International Journal of Innovation in Pharma Biosciences and Research Technology. 1(1): 1-8.

Lai, Wing-Fu. 2014. Progress in biotechnology for food applications Chapter: Fermentation technologies in food production Edited by: Wing-Fu Lai, Published by OMICS Group eBooks 731 Gull Ave, Foster City. CA 94404, USA.

Li, B., Qiao, M. and Lu, F. 2012. Composition, nutrition and utilization of *okara* (soybean residue). Food Reviews International. 28(3): 231-252.

Marko, A., Rakická, M., Mikušová, L., Valík, L. and Šturdík, E. 2014. Lactic acid fermentation of cereal substrates in nutritional perspective. International Journal of Research in Chemistry and Environment. 4(4): 80-92.

Ojokoh, A. and Bello, B. 2014. Effect of fermentation on nutrient and anti-nutrient composition of millet (*Pennisetum glaucum)* and soyabean (*Glycine max)* blend flours. Journal of Life Sciences. 8(8): 668-675.

O'Toole, D.K. 1999. Characteristics and use of *okara*, the soybean residue from soy milk production A Review. Journal of Agricultural and Food Chemistry. 47: 363–371.

Patel, D.N., Sutar, P.P. and Sutar, N. 2013. Development of instant fermented cereal-legume mix using pulsed microwave vacuum drying. Drying technology: An International Journal. 31(3): 314-328.

Ranadheera, R. Baines, SK and Adams, M.C. 2010. Importance of food in probiotic efficacy. Food Research International. 43(1):1 -7.

Roy, A., Bijoy, M. and Prabir, S.K. 2009. Survival and growth of foodborne bacterial pathogens in fermenting batters of *dhokla*. Journal of Food Science and Technology. 46:132-135.

Roy, A., Moktan, B. and Sarkar, P.K. 2007. Microbiological quality of legume-based traditional fermented foods marketed in West Bengal, India. Food Control. 18: 1405-1411.

Sheoran, O.P., Pannu, R.S. 1999. Statistical software package for agricultural research workers in recent advances in information theory, Statistics and Computer application. (Eds. Hooda, D.S. and Hasija, R.C. 139-143.

Sindhu, S.C. and Khetarpaul, N. 2005. Development, acceptability and nutritional evaluation of an indigenous food blend fermented with probiotic organisms. Nutrition and Food Science. 35: 20-27.

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