Int.J.Curr.Microbiol.App.Sci (2018) *7*(3): 1777-1787

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 7 Number 03 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.703.209

Organoleptic Acceptability, Nutritional Properties and Shelf Life of Oat Based Gluten Free Instant *idli*

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Keywords

Instant mixes, Organoleptic acceptability, Nutritional properties, Shelf life, Fat acidity

Article Info

Accepted:
16 February 2018
Available Online:
10 March 2018

A B S T R A C T

Instant mixes are commercially prepared mixture of dry ingredients as these are easy and fast to prepare. Keeping these facts in view, in the present study five types of gluten free instant *idli* were prepared by using instant mixes i.e., 40 per cent rice flour, 20 per cent mung bean flour and 5 per cent linseed powder in 60 per cent processed (malted, roasted, popped and flaked) and unprocessed oat flour. It was found that *idli* prepared from Type-I (unprocessed oat flour based blend), Type-II (malted oat flour based blend) and Type-III (flaked oat flour based blend) instant mixes fell in the category of 'liked moderately' whereas *idli* prepared from Type-IV and Type-V instant mixes were found in the category of 'liked slightly' to 'neither liked nor disliked'. The most acceptable *idli* was selected for their nutritional composition and shelf life. Water and oil absorption capacity was significantly higher in Type-II *idli* as compared to Type-III and Type-I *idli.* Whereas, Type-I *dhokla* exhibited higher bulk density. Nutritional properties showed that Type-II (malted oat flour based blend) *idli* had maximum protein (18.86%), carbohydrates (68.21%) and energy (389.95 Kcal/100g). Whereas, highest crude fibre (7.22%), ash (2.38%) and fat (5.33%) content was found in Type-I *idli*. Storage studies showed that all the three types of *idli* prepared from 3 months stored instant mixes were found in the category of 'liked moderately' to 'liked slightly' and acceptable up to 90 days of storage. Fat acidity content of all three types of *idli* was found within the permissible limit. It may be concluded that instant *idli* mixes could be stored up to 3 months successfully without any significant change in their sensory attributes.

Introduction

Celiac disease is an autoimmune inflammatory disease of the small intestine that can occur in genetically predisposed people due to ingestion of gluten (a protein found in wheat, rye and barley (Zannini *et al.,* 2012) which leads to damage in the small intestine villi (small finger like projections). The function of intestinal villi is to promote the nutrient absorption, as the villi get damaged, nutrients cannot be absorbed properly in the body leading to malabsorption of several important nutrients such as iron, folic acid and calcium, fat soluble vitamins and many other manifestations (Jnawali *et al.,* 2016; Tanwar and Dhillon, 2017). Till date the only treatment of people suffering from celiac

disease is to follow a gluten free diet (Rubio-Tapia *et al.,* 2013). Complete avoidance of gluten enables the intestine to heal, and the nutritional deficiencies and other symptoms to resolve (Dhankar, 2013). A strict adherence to gluten-free di*et al.,*so reduces the risk of developing many of the serious long-term complications related to untreated celiac disease.

However, following a gluten free diet might sound simple but it is not easy, as it not only involves eliminating gluten containing grains and all products that contain them, which requires constant vigilance, but there is also a sense of social isolation and pressure that accompanies the process (Bauman *et al.,* 2008).

The first consideration in the preparation of gluten free product includes the exclusion of any food or food ingredient that contains gluten, as celiac disease is triggered by the ingestion of gluten or its protein fraction. Oat is the only cereal containing a globulin or legume like protein avenalins, as the major (80%) storage proteins. It is currently a very popular coarse cereal in consumer demand due to its unique nutritional and health properties (Sharma *et al.,* 2010).

They are generally consumed as whole grains and hence the nutrients present are not lost during processing. They are excellent source of different dietary fibre compound of mixed linkage (1→3), (1→4) β-D glucan, arabinoxylans and cellulose. The incorporation of oats into a gluten free diet diversifies the celiac diet and also provides many health and nutritional benefits (Sharma and Chawla, 2012).

Keeping these facts in view, in the present study five types of oat based value added gluten free instant *idli* were prepared by using unprocessed and processed instant mixes.

Materials and Methods

Procurement of selected oat variety

One oat variety (OS-346) was procured from the Forage Section of the Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar, whereas rice, mung bean and linseed samples were purchased from local market.

All the samples were cleaned and stored in plastic containers till further use. The oat grain samples were processed by using various processing techniques.

Processing of oat grains

Different processing methods were used to process the oat grains:

The unprocessed and processed oat grains, rice and mung bean were subjected to milling to obtain flour. Linseed seeds were roasted and ground to obtain fine powder. Roasted oat flour, rice flour, mung bean flour and linseed powder separately in ratio of 60:40:20:5 and then roasted spices (mustard seeds and curry leaves). Added sodium bicarbonate, citric acid, *Eno* and salt and mixed all the ingredients well. Then packed and sealed in polyethylene pouches.

Reconstituted *idli* mix (100g) with curd (80g) and water (30g) then mix it properly to form a smooth batter. Poured the mixture in greased moulds and microwave for 2-3 minutes.

Organoleptic evaluation of oat based gluten free instant *Idli*

Instant *idli* were subjected to sensory evaluation with respect to color, appearance, aroma, texture, taste and overall acceptability by a panel of 10 semi trained judges, using 9 point hedonic scale.

Functional and nutritional properties of oat based gluten free instant *Idli*

On the basis of organoleptic acceptability instant *idli* prepared with unprocessed, malted and flaked oat flour based mix were selected for further nutritional analysis. Water absorption capacity of flours was measured by the method described by Singh and Singh (1991). Oil absorption capacity was done according to the method of Iyer and Singh (1997). For measuring the bulk density, grains were gently filled in a 100 ml graduated cylinder. The bottom of cylinder was gently tapped several times until there was no further diminution of the sample level either filling to the 100 ml mark. Bulk density was calculated as weight of sample per unit volume of sample (g/100 ml). The different protein fractions viz., albumin (water soluble), globulin (salt soluble), prolamin (alcohol soluble) and glutelin (alkali soluble) were determined according to the method of AACC (2000). Proximate composition such as moisture, protein, crude fat, crude fibre and ash was determined by employing the standard method of analysis (AOAC, 2000). Total carbohydrates were estimated by the following calculation method: Total carbohydrates (%) = 100 – (Crude protein+crude fat+crude fibre+ash). Total energy was calculated theoretically by using the following conversion factors 4.0, 4.0 and 9.0 Kcal/ g for protein, carbohydrates and fat, respectively, according to the method described by Paul and Southgate (1979) (Table 4).

Shelf life of most acceptable developed oat based gluten free instant *idli*

Sensory evaluation

Organoleptic evaluation of stored products were done for period of 3 months at interval of one month by a panel of ten semi trained judges for colour, appearance, aroma, texture, taste and overall acceptability using a nine-point Hedonic Scale.

Fat acidity

The fat acidity was determined by the standard method of analysis (AOAC, 2000).

Statistical analysis

Mean, standard error and CD (critical difference) were calculated for analysis of data (Sheoran and Pannu, 1999).

Results and Discussion

Five types of *idli* developed from instant *idli* mixes which were prepared by addition of 40 per cent rice flour, 20 per cent mung bean flour and 5 per cent linseed powder in 60 per cent unprocessed and processed oat flour. The data on organoleptic acceptability of oat based gluten free instant *idli* is presented in Table 1. Mean scores of colour of five types of *idli* ranged from 5.25 to 7.60, respectively. *Idli* prepared from (Type-I, Type-II, Type-III and Type-IV) instant mixes based on unprocessed, malted, flaked and roasted oat flour fell in the category of 'liked moderately'. Whereas *idli* prepared from (Type-V) instant mix based on popped oat flour got lowest scores of colour i.e. 5.25 which was 'liked slightly' by the penalists. Mean scores of appearance of all five types of *idli* were 7.72, 7.78, 7.58, 6.99 and 5.90 respectively, with *idli* prepared from Type-I, Type-II and Type-III instant mixes based on unprocessed, malted and flaked oat flour were found in the category of 'liked moderately'. However, *idli* which prepared from instant mixes based on (Type-IV and Type-V) roasted and popped oat flour was found to be in the category of 'liked slightly' to 'neither liked nor disliked'. Aroma scores of (Type-I, Type-II and Type-III) *idli* prepared from instant mixes based on unprocessed, malted and flaked oat flour were 7.18, 7.58

and 7.27, which were 'liked moderately' by the panelists. However, 6.90 and 6.59 aroma scores were obtained by Type-IV and Type-V *idli* which was 'liked slightly' by the judges. Type-IV and Type-V *Idli* differed significantly from other three types of *idli*. Texture scores of Type-I, Type-II, Type-III and Type-IV *idli* (mixes based on unprocessed, malted, flaked and roasted oat flour) were fell in the category of 'liked moderately'. Whereas the texture of *idli* prepared with popped oat flour (Type-V) based instant mix (6.60) was 'liked slightly' by the judges. It may be due to the fact that popping of oat grains imparts dryness to the *idli*. Taste scores of *idli* prepared from mixes using unprocessed, malted and flaked oat flour (Type-I, Type-II and Type-III) were 7.25, 7.29 and 7.48, respectively, which found in the category of 'liked moderately'. However, the taste of roasted and popped oat flour based *idli* (Type-IV and Type-V) was found in the category of 'liked slightly' to 'neither liked nor disliked'. Overall acceptability scores of all types of *idli* ranged from 5.95 to 7.53, being highest (7.53) in Type-II *idli* (malted oat flour based mix) and lowest (5.95) in Type-V *idli* (popped oat flour based mix).. Overall acceptability scores of *idli* made from mixes based on unprocessed, malted and flaked oat flour (Type-I, Type-II and Type-III) were found in the category of 'liked moderately' whereas *idli* made from roasted and popped oat flour (Type-IV and Type-V) based mixes were 'liked slightly' and 'neither liked nor disliked' by the panelists. Sharma *et al.,* (2010) also reported that supplementation with roasted oat flour resulted in decreased sensory scores of *idli* due to development of dark colour, burnt flavour and taste which are in close agreement with the present results. Water absorption capacity of *idli* prepared from Type-I instant mix (based on unprocessed oat flour) was 2.17 g/g, which increased significantly ($P \leq 0.05$) in *idli* prepared from Type-II mix (based on malted oat flour). Whereas, the *idli* prepared from Type-III mix (based on flaked oat flour) had almost similar (2.18 g/g) water absorption capacity as in *idli* prepared from Type-I mix. Non-significant differences were found between the water absorption capacity of *idli* prepared from Type-I and Type-III mixes. These results are in accordance with Murugkar *et al.,* (2013) who reported that water absorption index and water solubility index increased significantly in germinated mixes indicating the ability of flour to absorb more water. Other workers also reported similar results which are in close agreement with the present results (Ocheme and Chinma 2008; Gernah *et al.,* 2011; Ocheme *et al.,* 2015). Oil absorption capacity of all three types of *idli* was 1.89, 1.93 and 1.90 g/g, respectively. Highest (1.93 g/g) was observed in Type-II *idli* followed by Type-III and Type-I *idli* prepared from three different instant mixes. Deepali *et al.,* (2013) reported that germination promote/induced oil absorption capacity may be due to solubilization and dissociation of proteins leading to exposure of non-polar constituents from within the protein molecule (Table 2). Ocheme and Chinma (2008); Gernah *et al.,* (2011); Ocheme *et al.,* (2015) also reported similar results which are in agreement of present study. Bulk density was 0.67 g/ml in *idli* prepared from Type-I mix (based on unprocessed oat flour), which declined in *idli* prepared from Type-II and III mix (based on malted and flaked oat flour). The bulk density was almost similar in Type-I and Type-III *idli*. The values were 0.67 and 0.68 g/ml respectively. The bulk density of *idli* prepared from Type-I mix differed significantly from *idli* prepared from Type-II mix. Other workers (Elkhalifa and Bernhardt 2010; Onesmo 2011; Imtiaz and Burhan 2012) also reported that bulk density of products made from malted and flaked millet/pulses flour mixes had lower bulk density than products made from unprocessed millet/pulses mixes.

Table.1 Mean scores of organoleptic acceptability of oat based gluten free instant *idli*

Instant *Idli*	Colour	Appearance	Aroma	Texture	Taste	Overall Acceptability
Type-I	7.60±0.23	7.72±0.29	7.18±0.21	7.36±0.18	7.25±0.22	7.42±0.15
Type-II	7.61±0.23	7.78±0.21	7.58±0.23	7.41±0.16	7.29±0.12	7.53±0.12
Type-III	7.33±0.14	7.58±0.19	7.27±0.11	7.38±0.13	7.48±0.16	7.40±0.08
Type-IV	7.13±0.13	6.99±0.28	6.90±0.14	7.00±0.00	6.80±0.21	6.96±0.07
Type-V	5.25±0.58	5.90±0.52	6.59±0.14	6.60±0.22	5.45±0.38	5.95±0.17
CD (P≤0.05)	0.94	0.93	0.49	0.46	0.68	0.39

Values are mean ± SE of ten independent determinations
Type-I: Unprocessed oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-II: Malted oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-III: Roasted oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-IV: Popped oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-V: Flaked oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)

Table.2 Physico-chemical properties of oat based gluten free instant *idli* (on dry matter basis)

Instant *idli*	Water absorption Capacity (g/g)	Oil absorption Capacity (g/g)	Bulk Density (g/ml)	Gluten (g/100g)
Type-I	2.17±0.02	1.89±0.01	0.67± 0.01	ND
Type-II	2.20±0.01	1.93±0.00	0.62±0.02	ND
Type-III	2.18±0.05	1.90±0.02	0.68±0.00	ND
CD(P≤0.05)	0.02	0.03	0.04	-

Values are mean ± SE of three independent determinations ND=Not detected
Type-I: Unprocessed oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-II: Malted oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-III: Flaked oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)

Table.3 Protein fractions (%) of oat based gluten free instant *idli* (on dry matter basis)

Instant *idli*	Albumin	Globulin	Prolamin	Glutelin
Type-I	2.87±0.02	5.45±0.18	1.12±0.01	3.22± 0.02
Type-II	3.73±0.01	6.78±0.21	0.92±0.03	3.47±0.06
Type-III	3.60±0.03	6.32±0.15	0.99±0.03	3.33±0.01
CD(P≤0.05)	0.04	0.12	0.03	0.06

Values are mean ± SE of three independent determinations
Type-I: Unprocessed oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-II: Malted oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-II : Flaked oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)

Table.4 Proximate composition (%) and energy (Kcal/100g) of oat based gluten free instant *idli* (on dry matter basis)

Instant *idli*	Moisture	Crude protein	Crude fibre	Ash	Crude fat	Carbohydrates	Energy
Type-I	5.45±0.11	18.48±0.52	7.22±0.17	2.38±0.09	5.33±0.05	66.59± 1.66	388.00±2.81
Type-II	6.73± 0.14	18.86±0.61	6.28±0.17	2.21±0.03	4.63±0.09	68.21± 1.87	390.00±3.46
Type-III	6.39±0.06	18.61±0.45	6.31±0.21	2.02±0.01	4.68±0.01	68.19± 1.68	389.00±2.99
CD(P≤0.05)	0.61	NS	0.56	0.11	0.28	0.92	0.74

Values are mean ± SE of three independent determinations NS=Non-significant
Type-I: Unprocessed oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-II: Malted oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-III: Flaked oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)

Table.5 Effect of storage period on organoleptic characteristics of oat based gluten free instant *idli* mixes

Organoleptic characteristics	Storage period (Days)	Type-I	Type-II	Type-III
Colour	0	7.60±0.23	7.61±0.23	7.33±0.14
	30	7.40±0.14	7.30±0.15	7.15±0.13
	60	7.35±0.15	7.25±0.13	6.90±0.10
	90	7.00 ±0.00	6.80±0.13	6.50±0.16
Mean		7.33	7.24	6.97
CD (P≤0.05)	Storage period=N.S Treatments= N.S Interaction=N.S			
Appearence	0	7.72±0.29	7.78±0.21	7.58±0.19
	30	7.35±0.16	7.40±0.16	7.20±0.13
	60	7.15±0.10	7.30±0.21	7.00±0.14
	90	7.00±0.14	7.00±0.00	6.80±0.13
Mean		7.30	7.37	7.14
CD (P≤0.05)	Storage period=N.S Treatments= N.S Interaction= 1.39			
Aroma	0	7.58±0.23	7.18±0.21	7.27±0.11
	30	7.25±0.13	7.05±0.05	7.00±0.00
	60	7.00±0.14	6.80±0.20	6.95±0.05
	90	6.25±0.13	6.00±0.00	6.00±0.00
Mean		7.02	6.75	6.80
CD (P≤0.05)	Storage period=N.S Treatments= N.S Interaction=N.S			
Texture	0	7.36±0.18	7.41±0.16	7.48±0.16
	30	7.00±0.14	7.00±0.00	7.00±0.21
	60	6.50±0.16	6.20±0.13	6.10±0.10
	90	6.10±0.10	6.00±0.00	6.00±0.00
Mean		6.74	6.65	6.64
CD (P≤0.05)	Storage period=N.S Treatments= N.S Interaction=1.35			
Taste	0	7.25±0.22	7.29±0.12	7.48±0.13
	30	7.20±0.13	7.20±0.13	7.25±0.13
	60	7.10±0.10	7.00±0.10	6.80±0.13
	90	7.00±0.14	6.90±0.15	6.70±0.16
Mean		7.15	7.09	7.05
CD (P≤0.05)	Storage period=0.65 Treatments= N.S Interaction=N.S			
Overall acceptability	0	7.50±0.12	7.45±0.09	7.40±0.08
	30	7.24±0.05	7.19±0.06	7.12±0.04
	60	7.02±0.06	6.91±0.08	6.75±0.05
	90	6.67±0.04	6.54±0.03	6.40±0.05
Mean		7.11	7.00	6.90
CD (P<0.05)	Storage period=0.72 Treatments =0.83 Interaction= 1.44			

Values are mean ±S.E of ten independent determinations
Type-I: Unprocessed oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-II: Malted oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-III: Flaked oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)

Table.6 Effect of storage on fat acidity (mg KOH/100g) of oat based gluten free instant *idli* (dry matter basis)

Instant *idli*	**Storage Period (Days)**			
	0	30	60	90
Type-I	21.68±0.64	30.40±0.22	39.60±0.26	46.41±0.20
Type-II	22.54±0.28	31.92±0.53	40.52±0.36	47.54±0.35
Type-III	22.28±0.24	31.46±0.38	40.03±0.30	47.11±0.66
CD (P≤0.05)	Storage period =10.53 Treatments= 9.12 Interaction=N.S			

Values are mean ± SE of ten independent determinations
Type-I: Unprocessed oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-II: Malted oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)
Type-III: Flaked oat flour: Rice flour: Mung bean flour: Linseed powder (60:40:20:5)

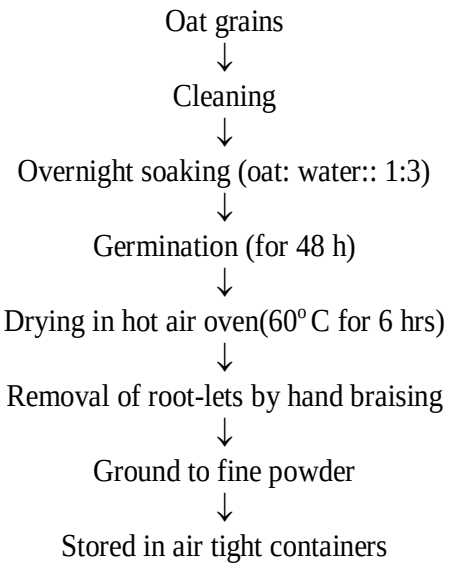

Fig. 3.1: Flow diagram for malting process

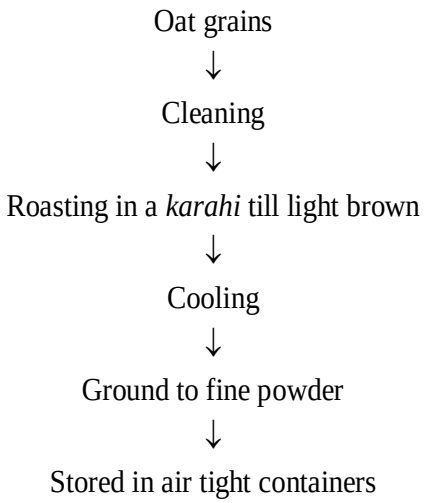

Fig. 3.2: Flow diagram for roasting process

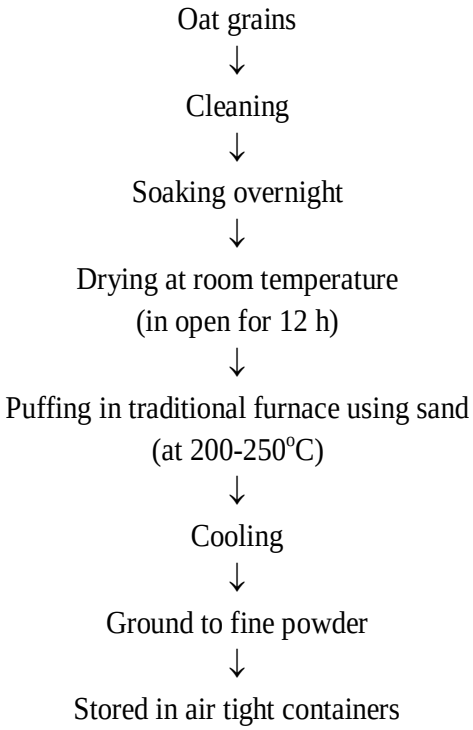

Fig. 3.3: Flow diagram for popping process

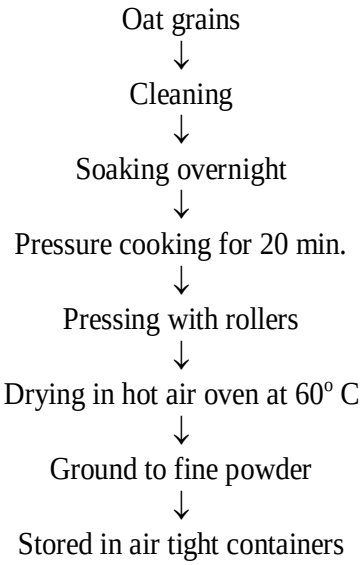

Fig. 3.4: Flow diagram for flaking process

It might be due to breakdown of complex compounds such as starch and proteins (Ocheme *et al.,* 2015; Takhellambam and Chimmad 2015). Gluten content was not found in any of three instant *idli*.

Albumin content was 2.87 per cent in *idli* which made from Type-I mix and it increased gradually in *idli* which prepared from Type-II and Type-III mix. Type-II *idli* had significantly (P≤0.05) higher (3.73%) albumin content followed by Type-III (3.63%) and Type-I (2.87%) *idli*. Globulin contents ranged from 5.45 to 6.78 per cent, respectively which were found highest (6.78%) in *idli* which prepared from Type-II mix (malted oat flour based mix) and lowest (5.45%) in Type-I *idli* (unprocessed oat flour based mix) (Table 3).

Prolamin content was significantly (P≤0.05) lowest in Type-II and Type-III *idli* (malted and flaked oat flour based mix) as compared to Type-I *idli* (unprocessed oat flour based mix). On mean basis, the prolamin content was found highest (1.12%) in Type-I *idli* followed by Type-III (0.99%) and lowest (0.92%) in Type-II *idli*.

Glutelin content was 3.22 per cent in *idli* which prepared from mix based on unprocessed (Type-I) oat flour which increased significantly (P≤0.05) with the use of malting and flaking processing methods. *Idli* which prepared from mixes based on malted (Type-2) oat flour had highest (3.47%) content of glutelin content followed by flaked (Type-III 3.33%) and unprocessed (Type-I 3.22%) oat flour. Other workers also reported similar results (Wu 1983; Moneim *et al.,* 2012; Rasane *et al.,* 2015) which are in agreement with the present results.

Moisture content of all the three types of *idli* ranged from 5.45 to 6.73 per cent, respectively, being highest (6.73%) in Type-II *idli* (malted oat flour based mix) and lowest in Type-I *idli* (unprocessed oat flour based mix). Protein content of all the three types of *idli* were 18.48, 18.86 and 18.61 per cent, respectively. Protein content was non-significantly increased by use of malted and flaked oat flour. Among them, Type-II *idli* (malted oat flour based mix) had non-significantly (P≤0.05) higher (18.86%) protein content followed by 18.61 per cent in Type-III *idli* (flaked oat flour based mix) and 18.48 per cent in Type-I *idli* (unprocessed oat flour based mix). Crude fibre content of all the three types of *idli* varied from 6.28 to 7.22 per cent, respectively, with the highest (7.22%) in Type-I *idli* and lowest (6.28%) in Type-II *idli*. Type-II and Type-III *idli* differed non-significantly from each other (P≤0.05). Ash content of all the three types of *idli* ranged from 2.02 to 2.38 per cent, respectively. Ash content of all three types of *idli* differed significantly (P≤0.05). Crude fat content ranged from 4.63 to 5.33 per cent, respectively in three types of *idli* made from processed (malted and flaked oat flour based mixes) and unprocessed oat flour based mixes. Maximum was observed in Type-I *idli* and minimum in Type-II *idli*. Non-significant difference was observed in Type-II and III *idli*. Similar results were also reported by other workers in products made from malted and unprocessed mixes (Kaushik *et al.,* 2010; Murugkar *et al.,* 2013; Tiwari and Awasthi 2014; Gupta and Brar 2015) who reported that sprouted mixes had significantly higher amount of protein but lower amount of crude fat, crude fibre and ash contents as compared to unprocessed mixes. Giridhar and Sathisha (2016) also reported that there was significant decrease in protein, crude fibre and fat content after flaking of millet grains which are similar as reported in flaked products in the present study. Carbohydrate content of all the three types of *idli* ranged from 66.59 to 68.21 per cent, respectively. Non-significant difference was observed in carbohydrate

content of Type-II and Type-III *idli*. Energy content ranged from 388 to 390 Kcal/100g, respectively in all the three types of *idli*. Similar results were also reported by earlier workers (Urbano *et al.*, 2005; Laxmi *et al.*, 2015) in processed and unprocessed instant mixes/products.

Shelf life of most acceptable developed value added gluten free products

Organoleptic evaluation and fat acidity

Stored products were studied for their sensory characteristics at an interval of 30 days upto acceptability by a panel of 10 semi-trained judges using nine-point Hedonic Scale (Table 5). Three types of *idli* prepared using fresh (0 day) and stored instant *idli* mixes (Type-I, Type-II and Type-III) (based on unprocessed and processed (malted and flaked) oat flour) were organoleptically evaluated. Mean scores of colour of *idli* prepared from fresh (0 day) three types of *idli* mixes were 7.60, 7.61 and 7.33 respectively, which fell in the category of 'liked moderately'. These scores decreased non-significantly with increase in storage intervals i.e 30, 60 and 90 days, which found in the category of 'liked moderately' to 'liked slightly'. Similarly, mean scores of appearance of *idli* prepared from fresh (0 day) three types of *idli* mixes were were 7.72, 7.78 and 7.58 which were 'liked moderately' by the panelists. These scores declined as on increasing the storage period up to 3 months and found in the category of 'liked moderately' up to 60 days. However, on 90 days of storage, the appearance of *idli* prepared from 90 days stored three types of *idli* mixes were found in the category of 'liked moderately' to 'liked slightly'. Aroma scores of all the three types of *idlis* developed from fresh (0 day) and 30th day stored *idli* mixes were 'liked moderately' by the judges. However, the aroma of *idli* developed from 60 days stored Type-I mix (unprocessed oat flour based mix) fell in the category of 'liked moderately' and *idli* prepared from 60 days stored Type-II and Type-III *idli* mixes were 'liked slightly'. The obtained mean scores were 7.00, 6.80 and 6.95, respectively. Whereas, the aroma of all the three types of *idlis* were 'liked slightly' on 90th day of storage. Similarly, the texture scores of three types of *idli* prepared from fresh (0 day) and 30 days stored *idli* mixes were 'liked moderately' by the panelists. Whereas, mean scores of texture of *idli* prepared from 60 and 90 days stored all the three types of *idli* mixes were 'liked slightly' by the judges. Taste scores of *idli* prepared from fresh (0 day) and 30 days stored three types of *idli* mixes were found in the category of 'liked moderately' However, the taste scores of *idli* prepared from 60 and 90 days stored *idli* mixes were found in the category of 'liked moderately' to 'liked slightly'.

Overall acceptability mean scores of *idli* prepared from fresh (0 day) Type-I, Type-II and Type-III *idli* mixes were 7.50, 7.45 and 7.40, respectively which decreased significantly with increase in storage period i.e., 30, 60 and 90 days. However, overall acceptability scores of *idli* prepared from stored Type-I (7.67) Type-II (6.54) and Type-III (6.40) *idli* mixes were still found in the acceptable category even up to 90 days of storage, might be due to low moisture content. Fat acidity content of *idli* prepared from fresh (0 day) stored *idli* mix (Type-I) had 21.68 mg KOH/100g. Whereas, 22.54 and 22.28 mg KOH/100g were found in *idli* prepared from fresh (0 day) stored Type-II and Type-III *idli* mixes. These were found to be increased with increase in storage interval. The values were 30.40, 39.60 and 46.41 mg KOH/100g in *idli* prepared from 30, 60 and 90 days stored *idli* mixes. Whereas, fat acidity content i.e 31.92, 40.52 and 47.54 mg KOH/100g in *idli* prepared from 30, 60 and 90 days stored Type-II *idli mix* and 31.46, 40.03 and 47.11

mg KOH/100g in *idli* prepared from 30, 60 and 90 days stored Type-III *idli* mix, respectively. All these values were found within the permissible limit (Table 6).

From the present study it can be concluded that there is great scope for utilization of unprocessed and processed (malted and flaked oat flour based mix) oat flour to develop value added gluten free instant *idli* mix for celiac disease patients having good shelf life.

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How to cite this article:

Bhawna Mehta and Sudesh Jood. 2018. Organoleptic Acceptability, Nutritional Properties and Shelf Life of Oat Based Gluten Free Instant *idli*. *Int.J.Curr.Microbiol.App.Sci.* 7(03): 1777-1787. doi: https://doi.org/10.20546/ijcmas.2018.703.209