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Evaluation of Chemical Properties of Bread Fortified with *Cicer arietinum* (Chickpea)

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Abstract

The present study was conducted to prepare baked breads from chickpea and refined flour. Chickpea flour was tested for ash content, moisture content, fat content, crude fibre, dietary fibre, carbohydrate, total energy, gluten content and alcoholic acidity. Refined wheat flour was supplemented with chickpea flour and used to bake breads at various ratios (refined flour/chickpea flour 100:0, 95:5, 90:10, 85:15). This was analysed for various attributes like colour, taste, texture, appearance and overall acceptability using the nine point hedonic scale by ten panelist. The 100% refined flour bread served as control. Refined flour has the maximum gluten content and hence is used in large quantity in the baked breads. For the evaluation of shelf life of the baked breads, the breads were packed in High Density Poly ethylene (HDPE) covers, and stored at ambient conditions (±1°C) and the panellist evaluated the sensory attributes of the bread at every alternate day for a span of a week. The result of sensory evaluation showed that there was a decline in all the sensory attributes as the days increased.

The lowest mean score were obtained on the fifth day and the highest mean scores were obtained on the first day indicating, the freshness of the breads declined as the days increased. Significant difference ($p< 0.05$) was seen amongst the bread on the 1st day on the basis of taste and texture. On the basis of taste all the breads vary significantly ($p<0.05$), C_{1C} (100% refined flour bread) being highly liked by the panellist and C_{11} (5% chickpea flour bread) the least and on the basis of texture C_{1C} (100% refined flour bread) was liked the most by the panellist while C_{13} (15% chickpea flour bread) was liked least.

Keywords: Chickpea flour,refinedflour,shelf life, sensory attributes.

Introduction

Chickpea are edible legumes belonging to the family (Fabaceae). They are also known by the name of (Garbanzo beans), and have a nut like taste with a high protein content in them. Chickpea proteins are considered suitable source of dietary protein due to excellent balance of essential amino acid composition (Zhang*et al.*, 2007). Chickpea is an important crop because of its nutritional quality. It is rich sources of complex carbohydrates, vitamins and minerals (Coasta*et al*, 2006). Its high lysine content makes chickpea an excellent enhancer of protein when combined with cereal proteins, which have a low content in lysine but are rich in sulphur amino acids (Iqbal *et al.*, 2006). Boye*et al.*(2010) reported that, due to its specific content of amino acids, chickpea protein presents high foam expansion and stability values compared to the legumes, such as pea and soya protein. They are also a source of high-quality protein and have been known as "a poor man's meat" (Isabel and garmen, 2003; Rincon *et al.*, 1998).

Chickpeas are most commonly associated with the cuisine of the Mediterranean and Asia - especially India (Geil and Anderson, 1994; Sri Kantha*et al.*, 1987). The scientific name *Cicer arietinum* is derived from the Roman name for chickpeas. The Roman family, Cicero, took their name from the chickpea, and arietinum is the Roman word for ram. Apparently, the shape of the chickpea looks like a ram's head - complete with curling horns (Geil and Anderson, 1994; Sri Kantha and Erdman, 1987). Chickpeas are the second most cultivated pulse worldwide and are third largest in terms of amount of pulse produced worldwide (Petterson*et al*., 1997; Singh *et al.*, 1991). They are a very important staple food for developing countries because they provide a cheaper form of protein than expensive animal sources. In addition, they are easy to grow - even in harsh arid environments, and are acceptable to the mostly vegetarian and semi vegetarian cultures that inhabit the Indian and Mediterranean regions (Pettersonet *al.*, 1997).

Chickpea protein digestibility (75-84%) is the highest among the dry edible legumes, perhaps due to chickpeas having the lowest concentration of trypsin inhibitors (Birender*et al.*, 1987; Newman *et al.*, 1988). Chickpeas are a rich source of vitamins, minerals and phytoestrogens. They contain folate, thiamine, riboflavin, niacin, pantothenic acid, vitamins C, A and E (GRDC, 2002). Chickpeas have a higher content of calcium and phosphorus than other pulses and are a good source of iron and zinc (Pettersonet *ol.*, 1997). Chickpeas are abundant in the isoflavonesformononetin and biochanin A, phytoestrogens common to many pulses (Mazur *et al.*, 1998; Murkies*et al.*, 1998; Setchell and Cassidy, 1999; Sharma, 1981; Siddiqui and Siddiqi, 1976). Chickpeas are relatively free of antinutrients, such as lectins, but do contain small amounts of saponins, oligosaccharides, some tannins and phytate (GRDC, 2002; Pettersonet *al.*, 1997).

Materials and Methods

Proximate Analysis

The flour was analysed for its moisture content using hot air oven at 105±10°C for 5 hours(IS 1155:1968), ash content using muffle furnace at 550±600°C for 3 hours (IS 1155:1968), protein content using kjeldhal method (IS 7219:1973), fat content using soxhalet extraction method (IS 548:1964), carbohydrate and total energy were analysed using the formula, crude fibre (IS 10226, Part 1:1982), dietary fibre (AOAC 19THEdition,Chapter 45), gluten content (IS 1155:1968) and alcoholic acidity (IS 1155:1968) were determined.

Ingredients	**Functionality**
Flour	Bread structure
Salt	Flavour, dough strengthener
Sugar	Flavour, fermentable carbohydrate source
Water	Solvent, plasticizer
Yeast	Leavening agent, flavour
Fat	Antistaling agent, increased loaf volume

Ingredients of bread and their function Flour (chickpea, refined wheat) and other ingredients i.e. salt, sugar, yeast, fat were purchased from the local market.

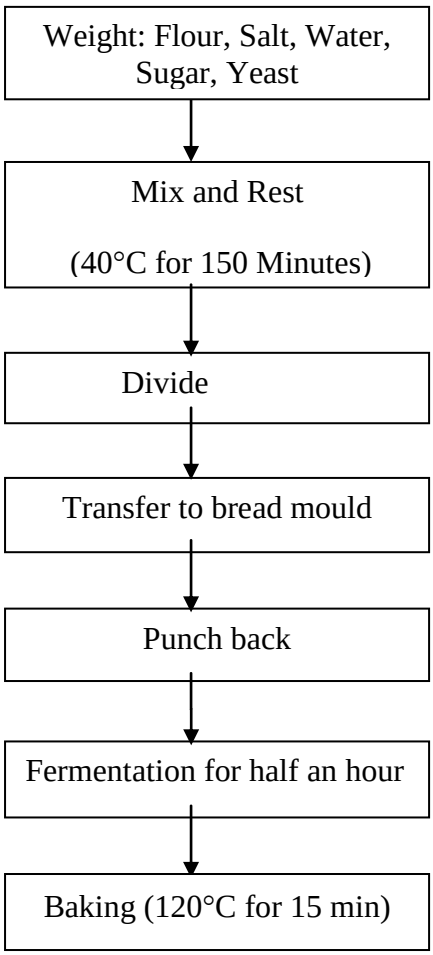
Composition of different breads

Bread	Ratio	Salt (g)	Sugar (g)	Yeast (g)	Water (mL)	Fat (g)
Refined : Chickpea flour flour (RF:C)	100:0	5.4	15	20	250	5.0
	95:5	5.4	15	20	250	5.0
	90:10	5.4	15	20	250	5.0
	85:15	5.4	15	20	250	5.0

Bread preparation

Breads were prepared by dry mixing of refined flour with different levels (0%, 5%, 10% and 15%) of chickpea flour. The blends were then again passed through a sieve for their uniform mixing. Yeast breads were prepared from all blends and straight dough development procedure was used. Total fermentation period of dough was 150 minutes with first punching after 90 minutes and second after an additional 30 min. Baking was done at 120°C for 15 minutes.

Flow chart of bread making process



Sensory analysis:

Developed products were evaluated using nine points hedonic scale by 8 to 10 semi trained panel of judges from the Department of Dietetics and Nutrition, M.M.I.C.T. & B.M (Hotel

Management), M.M. University, Mullana. The loaves were evaluated on the basis of colour, taste, texture, appearance and overall acceptability. The samples were coded with four random digits, which corresponded to each respective ratio of bread and served in random order to the panelists. The evaluators received water to drink before evaluating and were asked to rank each quality parameter of the bread.

Coding of breads

Day	**100% RF**	**95% RF + 5% C**	**90% RF + 10% C**	**85% RF + 15% C**
1	C_{1C}	C_{11}	C_{12}	C_{13}
3	C_{3C}	C_{31}	C_{32}	C_{33}
5	C_{5C}	C_{51}	C_{52}	C_{53}

RF= Refined Flour; C= Chickpea Flour

A hedonic scale of 9 points was used, each point meaning:

- Dislike extremely
- Dislike very much
- Dislike moderately
- Dislike slightly
- Neither like nor dislike
- Like slightly
- Like moderately
- Like very much
- Like extremely

Breads were also evaluated for the purchase intention, using the following scale:

- Would certainly not buy it
- Would probably not buy it
- Not sure if would buy it
- Would probably buy it
- Would certainly buy it

Statistical analysis From the data obtained the mean value and standard error of each sample was calculated. The significant difference between the organoleptic scores and supplementation composition of samples were tested using the analysis of variance (ANOVA).Test were compared at 95% significance level.

RESULTS AND DISCUSSIONS

TABLE 1. Nutrient composition of chickpea flour

Parameter	**Ash (%)**	**Moisture (%)**	**Protein (%)**	**Fat (%)**	**Carbohydrate (%)**	**total energy (%)**	**crude fibre (%)**	**dietary fibre (%)**	**Gluten (%)**	**alcoholic acidity (%)**
Chick pea flour	2.81	9.30	18.88	3.42	65.59	368.66	6.09	19.10	-	0.12

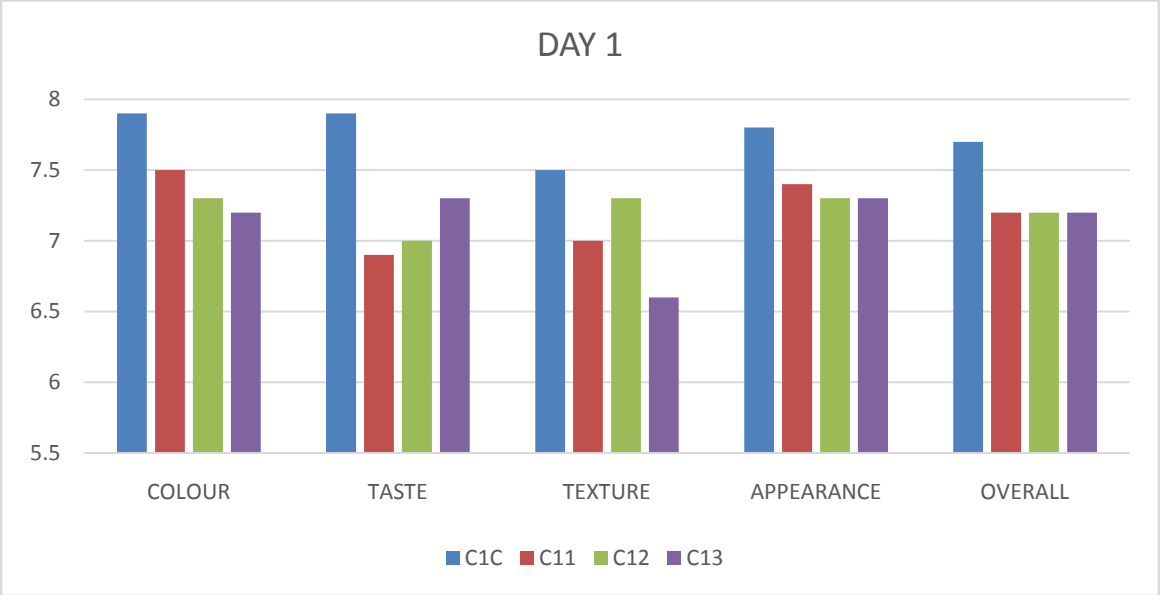
Table 1 represent the nutrient composition of chickpea flour used in present investigation.The ash content reported by various researchers varied from 0.27 to 0.40% (Yamamoto *et al*., 1996); 1.08 to 1.85 % (Ahmad *et al*., 2001; Butt *et al*., 2001).Paliwal and Singh (1985) reported variation inash 0.39 to 0.78 %for different wheat varieties. From the table it was found, ash content of chickpea flour was 2.81%. Lesser the ash content, more pure is the flour, higher is the ash content it means the flour is either contaminated with something or it is grown in mineral rich soil. According to Whiteley (1970), the moisture content of flour could vary from 11 to 15% depending upon the storage conditions and hygroscopic nature of the starch. Various researchers have shown that the moisture content varied from 8.19-11.94 % (Ahmad *et al*., 2001; Butt *et al*., 2001). According to the present study, moisture content ofchickpea flour was found to be 9.30%.
Birender *et al.*, 1987; Newman *et al.*, 1988 found that dried chickpeas contain 19.3% of protein, which compares favourably with wheat at 10.7%. According to the present study, protein content of chickpea flour was found to be 18.88%. This means the person who needs high protein diet should prefer eating chickpea flour. According to O'Dea, 1990; Rao, 1976 chickpeas have a relatively high fat content at 6%. According to present study, fat content of chickpea flour was found to be 3.42%. Carbohydrate content of chickpea flour was found to be 65.59%. Total energy content of chickpea flour was found to be 368.66 kcal. Paliwal and Singh (1985) reported variation in crude fibre 0.27 to 0.97 %, for different wheat varieties. According to present study, crude fibre content of chickpea flour was found to be 6.09%. Crude fibre helps patients with problems like diabetes and high level of blood cholesterol. According to O'Dea, 1990; Rao, 1976 the dietary fibre content of chickpea is 17%. According to present study, dietary fibre content of chickpea flour was found to be 19.10%. Dietary fibre helps in proper bowel movement, in maintaining blood glucose levels, blood cholesterol etc. More the alcoholic acidity, less is the shelf life. The alcoholic acidity of chickpea flour was found to be 0.22%. Ahmad (2001) found that the wet gluten and dry gluten ranged from 23.53- 38.71% and 7.51 to 13.52% respectively among wheat varieties. Paliwal and Singh (1985) found that the wet gluten content varies from 12.77 to 44.06% for different wheat varieties. According to present study, gluten content of chickpea flour was found to be absent and hence, it was concluded that it cannot be used in making bread item
.

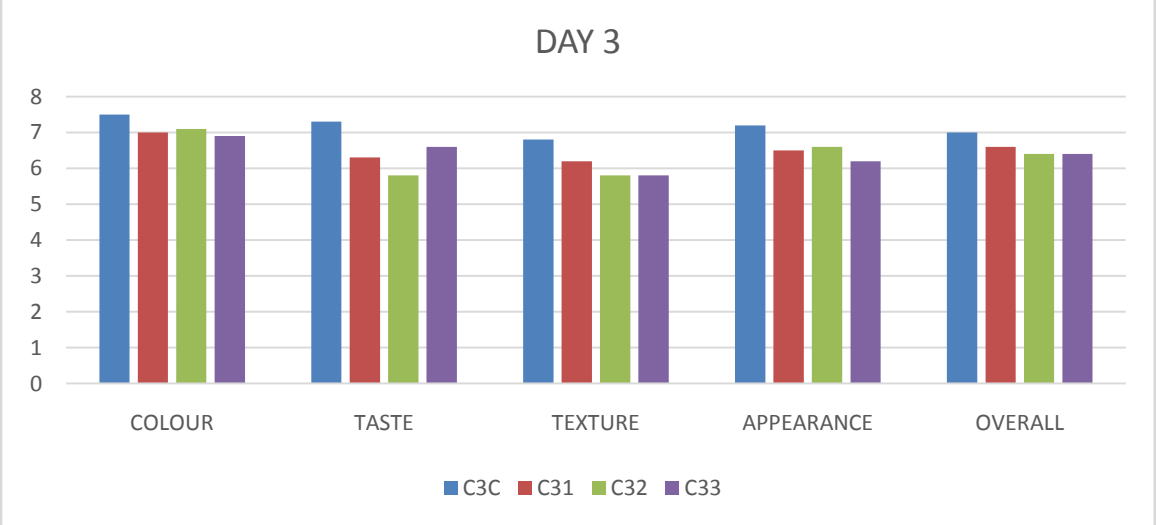
Chickpea flour breads:

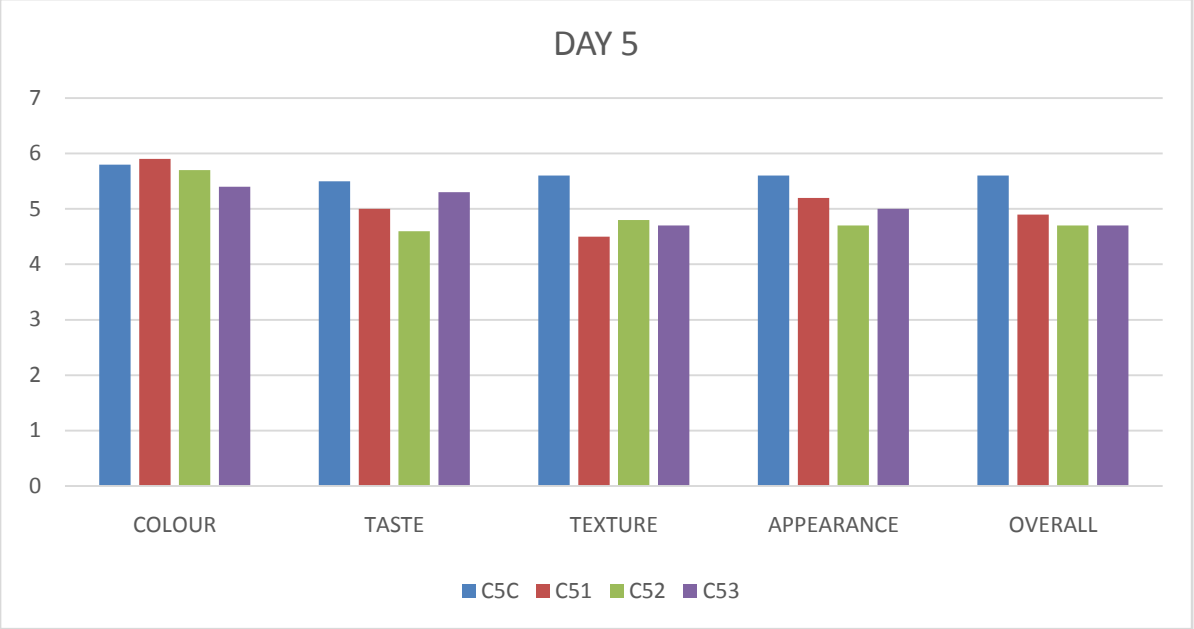
Table 2: Sensory attributes of chickpea flour bread of different days

Day	**Bread**	**Colour**	**Taste**	**Texture**	**Appearance**	**Overall acceptability**
1	C_{1C}	7.9	7.9	7.5	7.8	7.7
	C_{11}	7.5	6.9	7.0	7.4	7.2
	C_{12}	7.3	7.0	7.3	7.3	7.2
	C_{13}	7.2	7.3	6.6	7.3	7.2
	Total	7.475	7.275	7.1	7.45	7.325
	C_{3C}	7.5	7.3	6.8	7.2	7.0

3	C_{31}	7.0	6.3	6.2	6.5	6.6
	C_{32}	7.1	5.8	5.8	6.6	6.4
	C_{33}	6.9	6.6	5.8	6.2	6.4
	Total	7.125	6.5	6.15	6.625	6.6
5	C_{5C}	5.8	5.5	5.6	5.6	5.6
	C_{51}	5.9	5.0	4.5	5.2	4.9
	C_{52}	5.7	4.6	4.8	4.7	4.7
	C_{53}	5.4	5.3	4.7	5.0	4.7
	Total	5.7	5.1	4.9	5.125	4.975







Abdel Moneim E. Sulieman,*et al.* (2013) studied the supplementation of wheat flour with various levels of chickpea flourto assess consumer acceptability for the production bread of the wheat flour supplemented with chickpea flour. The results show that wheat flour supplemented with 5, 10 and 15% chickpea flour showed energy increases at 5% level, then decreased gradually at 10 and 15% levels of chickpea flour. The study recommended supplementation of bread with 5% chickpea flour to upgrade its nutritional value and quality.
Hefnawy, El-Shourbagy, and Ramadan (2012) determined the influence of the total or partial replacement of wheat flour by chickpea flour on the quality characteristics of toast bread. Chickpea flour at 15 and 30% substitution levels increased the stability and the tolerance index of the dough. Hence, it was proved that legume flours, due to their amino acid composition and fibre content, are ideal ingredients for improving the nutritional value of bread and bakery products.
In the present study, breads were evaluated for colour, taste, texture, appearance and overall acceptability using the 9 point hedonic scale for a span of 5 days, the bread being evaluated at every alternate day by the panellist. The mean result of the sensory evaluation on day 1, 3 and 5 is tabulated in Table 2. All the attributes (colour, taste, texture, appearance, overall acceptability) declined as the days increased, indicating the deterioration of breads over the time. The rate of deteriorating of the breads was almost the same. The lowest mean score were obtained on the fifth day and the highest mean scores were obtained on the first day indicating, the freshness of the breads declined as the days increased. Significant difference ($p< 0.05$) was seen amongst the bread on the 1st day on the basis of taste and texture. On the basis of taste all the breads vary significantly ($p<0.05$), C_{1C} (100% refined flour bread) being highly liked by the panellist and C_{11} (5% chickpea flour bread) the least and on the basis of texture C_{1C} (100% refined flour bread) was liked the most by the panellist while C_{13} (15% chickpea flour bread) was liked least.

Table 3: Multiple comparison of chickpea flour bread on the basis of colour

Day	Bread(i) Bread(j)	Mean	Std.	Sig.	95% confidence level

			difference (i-j)	error		Lower bound	Upper bound
1	C_{1C}	C_{11}	0.4	0.35875	0.275	-0.3361	1.1361
		C_{12}	0.6	0.35875	0.106	-0.1361	1.3361
		C_{13}	0.7	0.35875	0.061	-0.0361	1.4361
3	C_{3C}	C_{31}	0.5	0.31827	0.128	-0.1530	1.1530
		C_{32}	0.4	0.31827	0.220	-0.2530	1.0530
		C_{33}	0.6	0.31827	0.070	-0.0530	1.2530
5	C_{5C}	C_{51}	-0.1	0.35066	0.778	-0.8195	0.6195
		C_{52}	0.1	0.35066	0.778	-0.6195	0.8195
		C_{53}	0.4	0.35066	0.264	-0.3195	1.1195

Table 3 indicates sensory evaluation on the basis of colour of chickpea flour breads on different days. 100% refined flour bread is widespread in the market, so supplementation of 100% refined flour bread with 5%, 10% and 15% chickpea flour was evaluated in order to evaluate the consumer acceptability. On the basis of colour, there was no much significant difference ($p<0.05$) seen among the breads on any day. All the breads were equally liked by the panellist.

Table 4: Multiple comparison of chickpea flour bread on the basis of taste

Day	Bread(i)	bread(j)	Mean difference (i-j)	Std. error	Sig.	95% confidence level	
						Lower bound	Upper bound
1	C_{1C}	C_{11}	1.0*	0.23054	0.000	0.5270	1.4730
		C_{12}	0.9*	0.23054	0.001	0.4270	1.3730
		C_{13}	0.6*	0.23054	0.015	0.1270	1.0730
3	C_{3C}	C_{31}	1.0*	0.35172	0.008	-0.2783	1.7217
		C_{32}	1.5*	0.35172	0.000	0.7783	2.2217
		C_{33}	0.7	0.35172	0.057	-0.0217	1.4217
5	C_{5C}	C_{51}	0.5	0.39814	0.220	-0.3169	1.3169
		C_{52}	0.9*	0.39814	0.032	0.0831	1.7169

	C_{53}	0.2	0.39814	0.620	-0.6169	1.0169

∗ Indicate there was significant difference ($p<0.05$)

Table 4 indicated sensory evalution on the basis of taste. Control bread (100% refined flour bread) varies significantly ($p<0.05$) from other bread on the basis of taste on the 1st day of evaluation. C_{1C} (100% refined flour bread) was most liked by the panellist followed by C_{13} (15% chickpea flour bread), followed by C_{12} (10% chickpea flour bread) and C_{11} (5% chickpea flour bread) was liked the least by the panellist. On the 3rd day, C_{3C} (100% refined flour bread) and C_{33} (15% chickpea flour bread) did not had any significant difference but C_{3C} (100% refined flour bread) and C_{31} (5% chickpea flour bread); and C_{3C} (100% refined flour bread) and C_{32} (10% chickpea flour bread) vary significantly ($p<0.05$). On the 5th day of analysis, C_{5C} (100% refined flour bread) do not vary much with C_{51} (5% chickpea flour bread) and C_{53} (15% chickpea flour bread), but C_{5C} (100% refined flour bread) and C_{52} (10% chickpea flour bread) had significant difference ($p<0.05$). Control bread (100% refined flour bread) being more liked by the panellist.

Table 5: Multiple comparison of chickpea flour bread on the basis of texture

Day	Bread(i) bread(j)	Mean difference (i-j)	Std. error	Sig.	95% confidence level	
					Lower bound	Upper bound
1	C_{1C} C_{11}	0.5	0.34319	0.157	-0.2042	1.2042
	C_{12}	0.2	0.34319	0.565	-0.5042	0.9042
	C_{13}	0.9*	0.34319	0.014	0.1958	1.6042
3	C_{3C} C_{31}	0.6	0.35798	0.105	-0.1345	1.3345
	C_{32}	1.0*	0.35798	0.009	0.2655	1.7345
	C_{33}	1.0*	0.35798	0.009	0.2655	1.7345
5	C_{5C} C_{51}	1.1*	0.44305	0.020	0.1909	2.0091
	C_{52}	0.8	0.44305	0.082	-0.1091	1.7091
	C_{53}	0.9	0.44305	0.052	-0.0091	1.8091

∗ Indicate there was a significant difference ($p<0.05$)

On the basis of texture, on the 1st day G_{1C}(100% refined flour bread) and G_{13} (15% chickpea flour bread) vary significantly. G_{1C} (100% refined flour bread) was liked by the panellist very much and G_{13} (15% chickpea flour bread) was liked the least. On the 3rd day, G_{3C} (100% refined flour bread) and G_{31} (5% chickpea flour bread) do not show any significant difference but G_{3C} (100% refined flour bread) and G_{32} (10% chickpea flour bread); and G_{3C} (100% refined flour bread) and G_{33} (15% chickpea flour bread) show significant difference. G_{3C} (100% refined flour bread) was liked the most and G_{32} (10% chickpea flour bread) and G_{33} (15% chickpea flour bread) was equally disliked by the panellist. On the 5th day, G_{5C} (100%

refined flour bread) and G_{51} (5% chickpea flour bread) vary significantly. G_{5C} (100% refined flour bread) being highly acceptable on the basis of texture and G_{51} (5% chickpea flour bread) being the least acceptable.

Table 6: Multiple comparison of chickpea flour bread on the basis of appearance

Day	Bread(i)	bread(j)	Mean difference (i-j)	Std. error	Sig.	95% confidence level	
						Lower bound	Upper bound
1	C_{1C}	C_{11}	0.4	0.32546	0.23	-0.2678	1.0678
		C_{12}	0.5	0.32546	0.136	-0.1678	1.1678
		C_{13}	0.5	0.32546	0.136	-0.1678	1.1678
3	C_{3C}	C_{31}	0.7*	0.31002	0.032	0.0639	1.3361
		C_{32}	0.6	0.31002	0.063	-0.0361	1.2361
		C_{33}	1.0*	0.31002	0.003	0.3639	1.6361
5	C_{5C}	C_{51}	0.4	0.53037	0.457	-0.6882	1.4882
		C_{52}	0.9	0.53037	0.101	-0.1882	1.9882
		C_{53}	0.6	0.53037	0.268	-0.4882	1.6882

* Indicate there was a significant difference ($p<0.05$)

On the basis of appearance, there was no much significant difference ($p<0.05$) seen among the breads on the 1st day. On the 3rd day, G_{3C} (100% refined flour bread) and G_{31} (5% chickpea flour bread); and G_{3C}(100% refined flour bread) and G_{33} (15% chickpea flour bread) showed significant difference ($p<0.05$) indicating G_{3C} (100% refined flour bread) was most liked by the panellist followed by G_{32} (10% chickpea flour bread), followed by G_{31} (5% chickpea flour bread) and G_{33} (15% chickpea flour bread) was the least liked bread. On 5th day, there was not much significant difference seen amongst the breads .

Table 7: Multiple comparison of chickpea flour bread on the basis of overall acceptability

Day	Bread(i)	Bread(j)	Mean difference (i-j)	Std. error	Sig.	95% confidence level	
						Lower bound	Upper bound
1	C_{1C}	C_{11}	0.5	0.26352	0.069	-0.0407	1.0407
		C_{12}	0.5	0.26352	0.069	-0.0407	1.0407

		C_{13}	0.5	0.26352	0.069	-.0407	1.0407
3	C_{3C}	C_{31}	0.4	0.29313	0.184	-0.2015	1.0015
		C_{32}	0.6	0.29313	0.051	-0.0015	1.2015
		C_{33}	0.6	0.29313	0.051	-0.0015	1.2015
5	C_{5C}	C_{51}	0.7	0.36286	0.064	-0.0445	1.4445
		C_{52}	0.9*	0.36286	0.020	0.1555	1.6445
		C_{53}	0.9*	0.36286	0.020	0.1555	1.6445

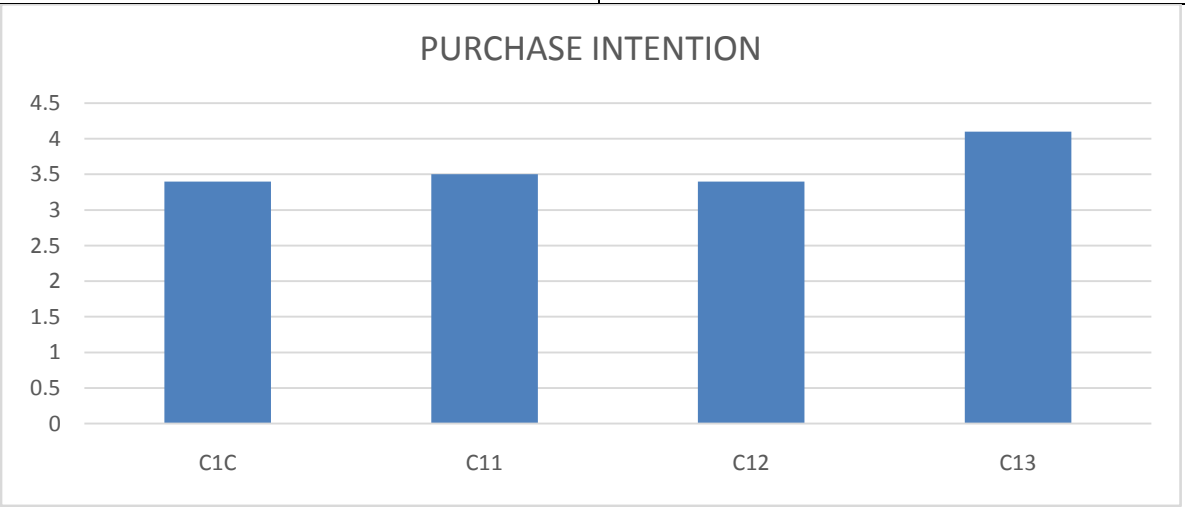
* Indicate there was a significant difference ($p<0.05$)

On the basis of overall acceptability, there was not much significant difference ($p<0.05$) seen among the breads on the 1st and 3rd day. However, on 5th day G_{5C} (100% refined flour bread) and G_{52} (10% chickpea flour bread); and G_{5C} (100% refined flour bread) and G_{53} (15% chickpea flour bread) showed significant difference ($p<0.05$). G_{5C} (100% refined flour bread) being the highly acceptable bread, followed by G_{51} (5% chickpea flour bread) and G_{52} (10% chickpea flour bread) and G_{53} (15% chickpea flour bread) were least liked by the panellist.

Evaluator's purchase intention: Table presents the evaluator's purchase intention test, which indicated the bread widely accepted by the consumer.

Table 8: Purchase intention card mean score of chickpea flour bread:

Bread	Purchase intention mean
C_{11}	3.4
C_{12}	3.5
C_{13}	3.4
C_{1C}	4.1
Total	3.6



The purchase intention card was filled by the panellist on the scale of 5, G_{1C} (100% refined flour bread) was the most liked bread among all the bread followed by G_{12} (10% chickpea flour bread), and G_{11} (5% chickpea flour bread) and G_{13} (15% chickpea flour bread) were equally likely by the panellist.

Summary and conclusion:

The purpose of this study was to determine the nutritional composition of chickpea flour and use it to make breads with refined flour in varied proportion and check its sensory attributes and detect the shelf life of the breads prepared.

The nutrient content of chickpea flour determined by (IS 1155; IS 7219; IS 548; IS 10226 and AOAC 2000) methods. Chickpea flour has high amount of ash, protein, fat whereas it has low amount of carbohydrate, alcoholic acidity and is gluten free.

Control bread was prepared from 100% refined flour and chickpea flour breads were prepared with the addition of 5%, 10% and 15% chickpea flour and the remaining was refined flour in the formulation.

In chickpea flour bread, the statistical analysis on the response on sensory attributes such as colour, taste, texture, appearance and overall acceptability by the panellist showed control bread (100% refined flour bread) had better colour, taste, texture, appearance and overall acceptability than the other breads but the other breads do not showed much significance difference ($p<0.05$). Sensory scores indicated that refined flour could be replaced to an extent of up to 15% with chickpea flour without affecting the sensory quality of breads much. To study the shelf life of the baked breads, the breads were packed in High Density Poly ethylene (HDPE) covers, sealed and stored at ambient conditions. Breads were drawn (every alternate day for a span of 5 days) and were tested for sensory attributes. Sensory evaluation for shelf life study results showed that, there was a decline in all the sensory attributes as the days increased.

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