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ORIGINAL ARTICLE

Enrichment of Bread with Soymilk and its Nutritional Evaluation

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ABSTRACT

Recently, there has been a trend towards creating nutritious and functional bakery items that include ingredients aimed at improving health benefits. The soybean seed was subjected for soymilk production which was used as functional ingredients, especially lactose intolerance, for the preparation of soymilk bread. Bakery products are easily modified into therapeutic products. Therefore, the present study was planned to develop soymilk bread and evaluate its nutritional value. The soybean was soaked overnight, shell was removed, crushed into grinder, diluted in warm water, filtered to obtain the soymilk and store cooled. The soymilk was heated, cooled and used for bread preparation. On the bases of primary trials bread with different soymilk concentration i.e., 85, 90 and 95% replacement with water in the standard recipe served as treatments while bread with no soymilk served as control. All the breads were subjected to sensory appraisal by the panel of judges to use interior and exterior uniqueness on the next day of preparation. The bread prepared using 90% replacement of soymilk, ranked the highest in taste and aroma, texture and grain and overall acceptability thus considered as the optimized bread (i.e., soymilk bread) and analysed further for nutritional quality. The protein, fat, ash, iron and calcium content of soymilk bread was higher as compared to control by 26.45, 11.95, 33.50, 29.00 and 39.88%, respectively. The results are in confirmation with other study. As expected, there was about 1.26 times higher protein in soymilk bread than control. Calcium content of soymilk bread was higher (310.41 mg%) as compared to control (240.63 mg%). There was

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about 40% percent increase in iron content of optimized bread than normal bread. An acceptable bread with superior sensory quality and nutritional value could be developed using soymilk. Such other bakery products could be developed using soymilk.

KEYWORDS

• Bread • Soymilk • Health Food • Bakery Products • Nutraceuticals

INTRODUCTION

The search for a nutritious processed food is increasing in the Indian population. As a result, food industry has to develop popular food products as nutraceuticals which contributes health benefits to the consumers. The consumption of bread has steadily increased and has become a significant staple food even in developing countries like India, as an integral breakfast product within cereal based groups. Over 9 billion kg of bread is produced worldwide annually.[1]

Soymilk is made from soybean (Glycine max), a high-quality soy protein source that is an alternative to dairy milk due to its health benefits.[2] Soymilk has been also reported as nutritive approach to health promoting for the children when it is use as a fortified cereal based conventional foods such soymilk bakery products (bread, cakes and biscuit).[3,4] studied the effect of soymilk on rice flour bread whereas[5] studied the effect of soymilk on bread (produced from wheat flour) at various levels of inclusion. These studies however did not optimise the incorporation of soymilk in bread making using Response Surface Methodology (RSM).

Increasing health consciousness and easy modification of bakery products has led to their development as therapeutic products suitable to individual needs.[6-7] Soymilk is nutritious and also expected to helpful to improve sensory quality of bakery products. The soybean seed was subjected for soymilk production which was used as functional ingredients, especially lactose intolerance, for the preparation of soy bread. Bakery products are easily modified into therapeutic products. Therefore, the present study was planned to develop soymilk bread and evaluate its nutritional value.

MATERIALS AND METHODS

1. Raw materials:

Soybean and other ingredients such as refined wheat flour, oil, iodized salt, instant yeast, sugar were purchased from the open market of Anand city in Gujarat state in Western India.

2. Soymilk extraction:

The soybean was sorted for uniform quality, cleaned and washed. Ten it was soaked overnight in about six times water. That was warmed (50°C, 15 minutes) and shell were removed by means of stress of two hands and cleaned with continues flow of replacement tap water. Next that soyabean were crushed into grinder and diluted with seven times warm water (50°C). The slurry was then filtered through masculine cloth to obtain the soymilk. The milk was heated at 95°C for 5 mins, cooled and stored at freezing temperature before being used. The milk was allowed to room temperature (about 1 to 1½ hours) before being used for bread preparation.

3. Experimental design:

The Completely Randomized Design (CRD) was adopted to achieve the highest quantity of soymilk with acceptable quality bread. The effect of soymilk inclusion soymilk (85, 90 and 95%) and Water (15, 10 and 5%) on the nutrient content of the bread samples, were investigated. The objective of the optimization was to create bread with the maximum protein content by substituting water with soymilk having acceptable quality of bread.

4. Product development:

A standard simple bread recipe[8] was used to prepare the bread with some modifications, substituting water with soymilk as described in Table 1. Bread processing steps for the same

also presented as Figure 1. Baking was carried out at the School of Baking, Faculty of Food Processing Technology, Anand Agricultural University, Anand, Gujarat, India.

Table 1: Formula for control and soymilk replaced breads

Product Ingredients	Quantity (baker's percentage)			
	Control Bread	Soymilk Replaced Bread		
	(T_1)	(T_2)	(T_3)	(T_4)
Flour	100	100	100	100
Oil	4.0	4.0	4.0	4.0
Sugar (powdered)	7.0	7.0	7.0	7.0
Yeast (Dry)	1.5	1.5	1.5	1.5
Salt	1.5	1.5	1.5	1.5
Water	65	20	18	16
Soymilk	00	55	58	61

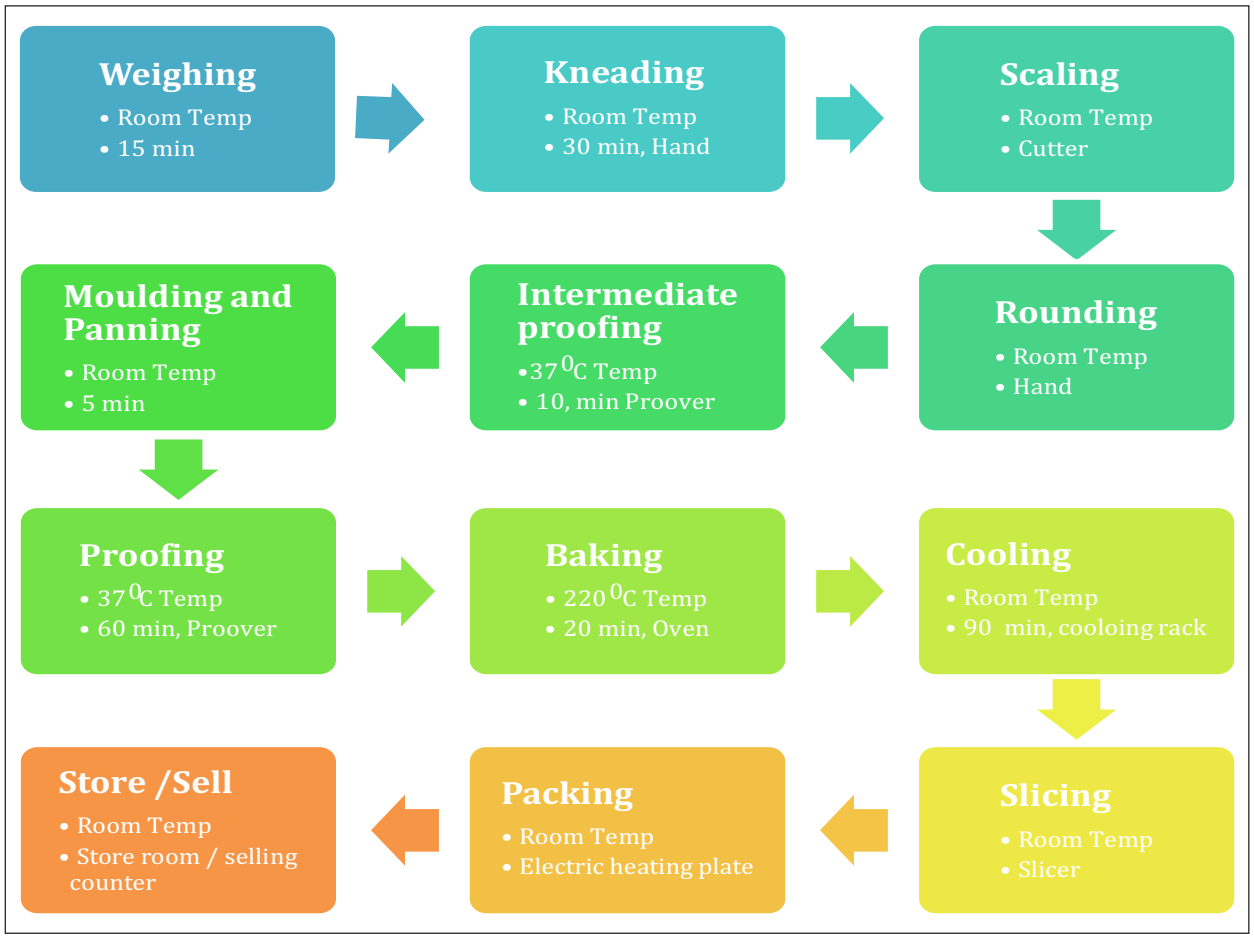

Figure 1: Flow chart for bread processing

For that, various primary trials of bread preparation were carried out by replacing water with soymilk. On the bases of their results in the final formula water was replaced with soymilk at 85, 90 and 95% and evaluated by a panel of semi trained experts (6 judges X 5 replications) using a composite scoring test after 24 hrs. of preparation as normally bread consumed by clients after a day of preparation due to transportation and marketing chain.

Control bread was prepared using the commercial formula (i.e. 0 % soymilk).

5. Sensory evaluation:

The sensory evaluation was conducted with 30 semi trained panelists from the University faculty members and students of Food Science and Technology for Development Studies at School of Baking, Polytechnic for Food Technology and Nutrition and College of Food Processing Technology using a composite scoring test. Samples were coded with three digit codes and presented to the panelist to evaluate their sensory attributes like volume, crust character, shape and bake, crumb color, taste and aroma, texture and grain and overall acceptability.

6. Nutritional Quality evaluation:

Finally selected and control breads were break into piece and sun dried to remove moisture. After drying, proximate (moisture, ash, protein, fiber and fat content) as well as two important minerals (calcium and iron) analysis were carried out as per standard methods.[9]

7. Statistical analysis:

The data thus obtained was analyzed statistically by running standard SPSS program using two factorial Completely Randomized Designs (CRD) and ANOVA / Duncan's test techniques by using software statistical 13.0.[10] The experimental data obtained were evaluated for multiple regression and the significance of the regression coefficients using by F-test and the coefficient of variation (CV). The degree of significance was evaluated with a 0.05 significance level. Comparison between two breads were calculated by t-test.

RESULTS AND DISCUSSIONS

The results obtained are tabulated and/or represented graphically and discussed below, mainly in two parts i.e., sensory score and nutritional value.

1. Sensory profiling of soy bread:

Various sensory characteristics judged by the penal of semi trained experts and score assigned by them were analysed statistically and discussed below under individual head.

Table 2: Sensory scores of breads prepared by replacing water with different levels of soymilk

Characteristic Product	Volume (15)	Crust character$ (5)	Shape and bake@ (10)	Crumb colour (10)	Taste and aroma (30)	Texture and Grain (20)	Overall acceptability (10)
100% Water	10.33^{b} ± 0.29	3.69^{b} ± 0.10	7.05^{b} ± 0.15	8.83^{a} ± 0.09	21.00^{c} ± 0.72	13.77^{c} ± 0.35	7.33^{b} ± 0.14
85% SM + 15% water	10.91^{b} ± 0.23	3.77^{b} ± 0.07	7.66^{b} ± 0.14	7.77^{b} ± 0.10	22.66^{b} ± 0.36	14.77^{b} ± 0.32	7.88^{b} ± 0.22
90% SM + 10% Water	**11.08^{b}** ± 0.32	**3.90^{a}** ± 0.05	**8.83^{a}** ± 0.11	**7.00^{c}** ± 0.19	**23.75^{a}** ± 0.25	**14.94^{a}** ± 0.18	**7.97^{a}** ± 0.11
95% SM + 5% Water	11.25^{a} ± 0.17	3.97^{b} ± 0.07	7.66^{b} ± 0.16	6.84^{b} ± 0.16	22.16^{b} ± 0.35	14.66^{b} ± 0.28	7.22^{c} ± 0.12
'F' Value	23.56**	18.41**	27.10**	28.64**	29.51**	38.01**	34.11**
CV%	0.10	0.08	0.08	0.08	0.08	0.08	0.09

SM = Soymilk (Percentage of Water replaced with Soymilk)

$ Crust character = Colour and nature of the crust

@ Shape and bake = Symmetry of shape and uniformity of bake

Values are Mean ± SEM scores of a composite scoring test by a panel of 6 judges X 5 replications

Means bearing the same superscript within the column do not differ significantly ($p \leq 0.05$) ** $p \leq 0.01$

Values in parentheses indicate number of maximum score

Figure 2 Sensory scores of control and optimized soymilk bread

Fig 3: Optimized Soymilk bread

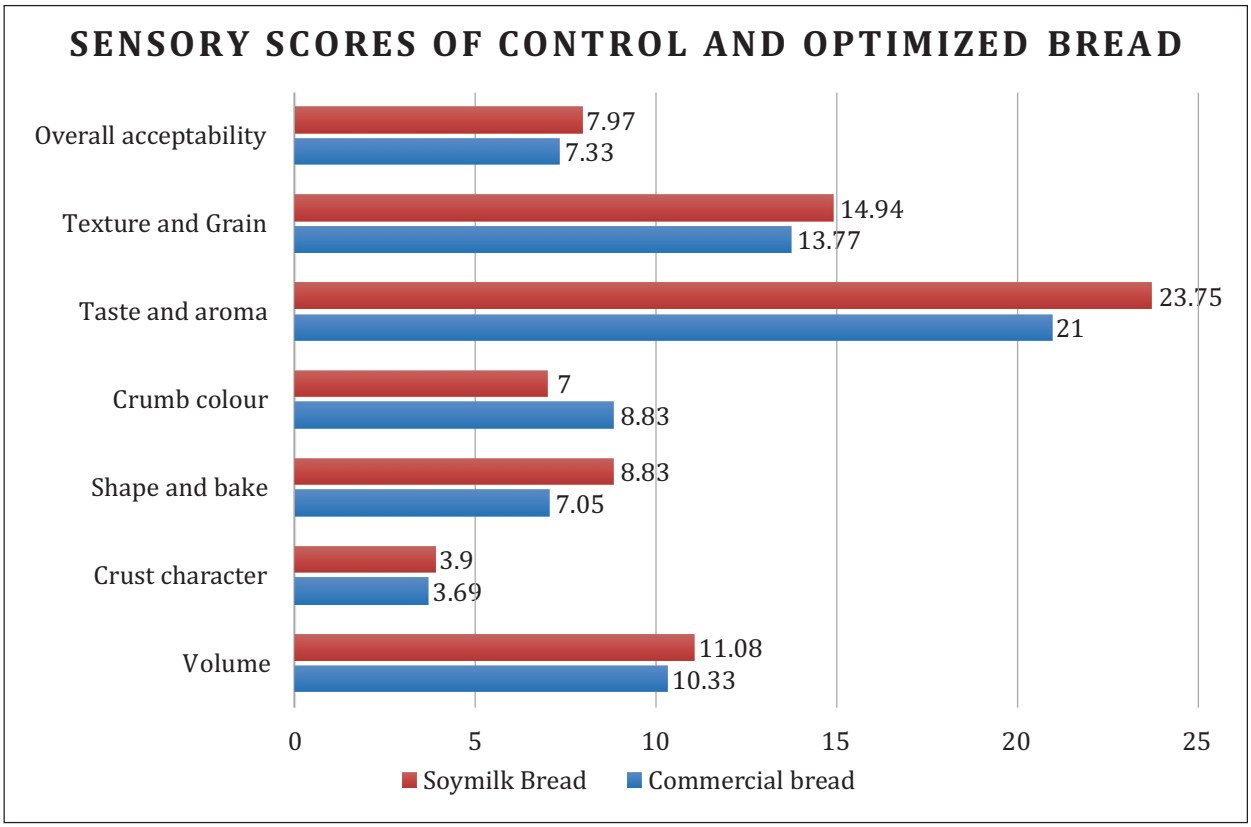

Figure 2: Sensory scores of control and optimized soymilk bread

1.1 Volume:

Effect of treatments on loaf volume of the soymilk bread were observed in increasing trend as the level of soymilk increased. Moreover, that were higher as compared to control also. The soymilk protein strengthens the gluten that increase the gas retention capacity and ultimately increases the bread volume. Results of the present study are positively opposite to,[13] they observed that, addition of soy flour results in disruption of the gluten system due to high fat that prevent oven spring and collapse the dough results in reduction in loaf volume

1.2 Colour and nature of the Crust:

The crust character score was ranged from 3.69±0.10 to 3.97±0.07 due to variation in level of soymilk. As similar to volume crust character significantly increases with the increasing of soymilk concentration. However,[12] found opposite results when they tried to add soya protein isolates for cookie preparation.

1.3 Symmetry of shape and uniformity of bake:

The score was varied from 7.05±0.15, the lowest, for control bread to 8.8.3±0.1, the highest, for 90% soymilk bread and was significantly differ from rest of the breads. However, the difference between the score were not much.

1.4 Crumb color:

Crumb color of the soymilk bread with 90% replacement was significantly different from rest of the breads. However, a deceasing trend in the crumb colour was observed as increasing the soymilk level. This is done due to maillard and caramelization reactions.[10] In soy bread crumb color was increased from white to cream and yellowish cream.[12]

1.5 Taste and aroma:

Taste and aroma score was ranged from 21.00±0.72, the lowest, to 23.75±0.25, the highest, due to variation in treatment. The taste and aroma for soymilk bread was observed significantly higher than control with the highest score for 90% soymilk bread. However, our results are opposite in positive way to.[5] They observed a decreasing trend with increasing soymilk powder replacement to white flour.

1.6 Texture and Grain:

As similar to taste and aroma soymilk breads had singingly higher sensory score for texture and grain as compared to control (i.e., without soymilk). Again, similar to taste and aroma, the texture and grain for 90% soymilk bread was scored the highest and was significantly differ from rest of the soymilk as well as control bread. The crumb texture for different level of soy flour addition resulted in textural variations.[12]

1.7 Overall acceptability:

Overall acceptability score of soymilk bread with 90% soymilk was the significantly higher (7.97±0.11) as compared to control (7.33±0.14) as well as rest of the soymilk bread (7.88±0.22 and 7.22±0.12 for 85% and 95% soymilk, respectively). All the treatments were observed on top of standard scores of suitable results. Just like the milk or milk powder the baking properties of soymilk bread are positively affected and the organoleptic characteristics of the bread due to the naughty flavour of soymilk and presence of different type of sugars and other nutrients.

The bread prepared using 90% replacement of soymilk to water, ranked the highest in all the sensory characteristics except volume, colour and nature of the crust and crumb colour, where it scored the second highest. Thus, it was considered as the optimized bread (i.e., soymilk bread) and analysed further for nutritional value. The numerical responses showed that 0 % water and 100 % soymilk gave an optimum product with 1.00 desirability.[15] It shows that there is a little difference between level of soymilk addition as compared to present study, that means both the studies are complement to each other.

Comparison between different sensory attributes for control and optimized soymilk bread are presented graphically in Figure 2. The photograph of the optimized soymilk bread prepared in laboratory is shown as Figure 3.

Figure 3: Optimized Soymilk bread

2. Nutritional Quality Characterization:

Analysis for proximate nutrients as well as two important minerals which are expected to increase in experimental bread were carried out. A two-sample t-test analysis on data for optimised soymilk bread recipe and a commercial bread, (control) are presented in Table 3. Percent change in various nutrients between both the breads are also calculated and presented in the same table.

1 Moisture contents

The moisture content of optimized bread is lower than control. The moisture content of both breads is higher and in reverse order than reported by.[15] They found 27.9 and 31.8 % moisture for control and 100% soymilk bread, respectively.

Table 3: Nutritional composition of control and optimized soymilk bread

Nutrients Product	Moisture (g%)	Carbohydrates (g%)	Fat (g%)	Protein (g%)	Ash (g%)	Fiber (g%)	Calcium (mg%)	Iron (mg%)
Control	35.69	52.06	3.18	7.07	2.00	Not Detected	240.63	3.41
Experiment	33.60	51.23	3.56	8.94	2.67	Not Detected	310.41	4.77
t-value	4.52**	3.32**	3.47**	8.45**	10.55**	-	9.62**	16.92**
Percent Change	-5.85	-1.59	11.95	26.45	33.50	-	29.00	39.88

Values are Mean scores of 2 × 5 replications
** p ≤ 0.01, * p ≤ 0.05

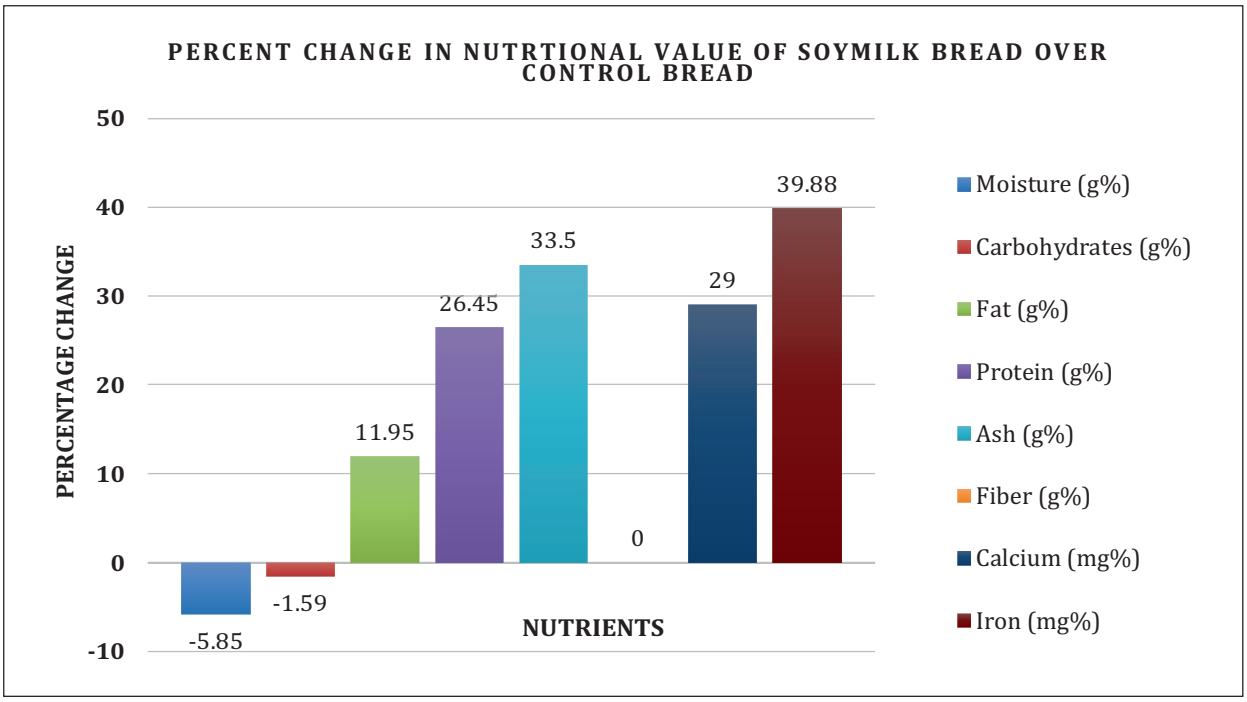

Fig 4: percent change in nutritional value of soymilk bread over control bread

2. Carbohydrate content:

Carbohydrate content was more or less similar in both types of breads (51.23, 52.06 g% in optimized and control bread, respectively).

3. Fat content:

Fat concentrations of the soymilk bread was 12% higher percent change than control (i.e. 3.56g%, 3.18g%).[13] also observed that the crude fat content in the commercial bread (without soymilk) was markedly (p =0.001) different from the optimized type (100% soymilk) nearly 1.5 times lower. The difference in fat content could be due to the soymilk used in the optimized bread since soymilk contains a significant amount of fat.[16]

4. Protein contents:

As expected, there was about 1.26 times higher protein in soymilk bread than control.[5] also observed, the crude protein content of the optimized bread (100% soymilk) was about 1.2 times higher than the commercial bread (without soymilk). The relatively high level of crude protein in soymilk[16] could explain the increased crude protein content of the optimized bread. The result of present study is in accordance with previous results and reasoning.

5 Ash contents:

Ash content of soymilk bread was significantly higher than control, though there

was very little difference inbetween them. Ash contents of Soy bread samples were increased due to addition of soymilk powder,[5] results are similar to these results.

7 Calcium content:

Expectedly, calcium content of soymilk bread was higher (310.41 mg%) as compared to control (240.63 mg%). Calcium is important for bone and teeth, that is found more in soybean therefore it was also expected to be higher in soymilk and ultimately in optimized bread, could be the base for high calcium in optimized bread.

6 Iron content:

As similar to calcium iron content of soymilk bread was higher as compared to control. Thera was about 40% percent change increase in iron content of optimized bread. Iron is important part of haemoglobin in blood, that is found more in soybean therefore it was also expected to be higher in soymilk and ultimately in optimized bread.

It is observed that, except moisture and carbohydrate all other nutrients were increased when soymilk was replaced with water in bread preparation. That might be due to that, water contain practically no nutrients. The percent increase/decrease in nutritional value of soymilk bread over control presented graphically in Figure 4.

CONCLUSION

Incorporating soymilk in the bread preparation significantly positively impacted the bread's nutritional quality, especially protein, ash, calcium and iron and fat. Furthermore, the inclusion of soymilk in the bread preparation significantly improves almost all the characteristics, especially taste and aroma, texture and grain, crumb and crust colour and finally overall acceptability. Thus, soymilk enrichment of bread could be used as health benefit product. Out of the soymilk bread samples (85%, 90% and 95%), the inclusion of 90% soymilk produced was more acceptable and preferred by the consumers. Therefore, it is recommended that the technology of using soymilk should be encouraged among food industries to make economic use of local raw materials to producing high quality food products rich in protein such as bread to boost food security and to improve the nutritional status of the nation.

Future scope

It is recommended that the composition of the soymilk bread recipe should be assessed for non-nutritional benefits, including its antioxidant properties and essential bioactive compounds such as phytoestrogen and Omega-3 fatty acids.

Like bread other fermented products such as pizza base and bun, cakes and pastries as well as laminated products like khari and puff where more water is used could be modified by utilizing soymilk having more sensory acceptability and nutritional quality.

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