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Studies on physico-chemical characteristics and texture analysis of bread with incorporation of bitter gourd powder

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Abstract
The present investigation was carried out to study the physical and chemical characteristics of bread. Physical properties of bread are such as loaf weight, loaf height, loaf volume; specific volume and baking loss were evaluated. The loaf weight of bread was 258.66g, loaf height was 5.83cm, loaf volume and specific volume was 627.59 ml and 3.63 ml/g. Moisture content and baking loss of prepared bread was 30.63% and 25.56%. The average proximate constituents such as moisture, carbohydrate, protein, fat and ash content was determined of bread. Carbohydrate content of bread was 51.56%. Protein and fat content of bread was 7.05% and 6.31% respectively. The ash content and fibre content was 1.73% and 2.72% respectively. Minerals such as calcium, potassium, magnesium, iron and zinc of bread were evaluated. The minerals were calcium (80.81mg), potassium (216.6mg), iron (2.98mg), magnesium (25.94mg) and zinc (1.83mg) respectively. Texture of bread was measured using *TA XT2* texture analyser (stable micro system) within 24 hours after preparation. The results of texture analysis of bread are hardness was 0.848kg, cohesiveness and springiness of bread was 0.66 and 1.043 respectively. Gumminess was 0.559kg and adhesiveness was -0.003 kg/sec. The obtained study was found to be significant for the development of bakery food product helps to enhance the nutritional content and health benefits. This type of product development technology helps to improve the market and statistics of bakery industries.

Keywords: Bread, physico-chemical characteristics, texture analysis

Introduction
Breakfast is frequently referred to as the most important meal of the day, as it provides fuel and calories for the day's activities. A rising collection of scientific evidence now backs up the argument that breakfast is a very important meal. The first point to note is that failing to eat something at the start of the day can have surprisingly substantial health implications for people involved. Because of their usefulness in everyday life bakery items have taken on a new dimension in modern times. The bakery business has carved out a distinct place in the market by selling baked goods to people all over the world as a result of increased demand for baked food products and changing consumer patterns. The bakery industry expands at a pace of 10.07% every year. Bread is growing popularity in society and it has been revealed that the bakery industry is experiencing a steady increase in sales. In the development of functional food bread preparation innovation and the addition of functional ingredients are critical. The bread sector in India is the largest among the processed food industries, with production constantly expanding in the country. Bread and biscuits are the two most popular bakery goods, accounting for around 82% of total sales (Somayeh *et al.*, 2012) [11].
In India, bread is commonly consumed for breakfast and throughout the day. Bread has a lengthy history of evolution adopting various procedures dough producing formulas and ingredients. It is one of the most widely consumed goods. Consumer interest in health and well-being is driving innovation in the bread industry where a variety of breads with extra wholegrain, nuts and high fibre are already available. Partially replacing wheat flour with alternative functional ingredients such as fruits and vegetables is a potential strategy for increasing photochemical and Nutraceuticals in the diet especially in high-consumption countries like India and hence enhances bread industry innovation. Bakery items have been increasingly popular in India, as indicated by a twofold growth in production over the last few years. Despite the fact that wheat is consumed in a variety of forms including noodles, cookies, cakes and ready-to-eat cereals bread has established itself as a key staple and a convenient cuisine throughout the world, particularly when produced according to regional preferences. Bread has been a staple of man's diet for at least 6,000 years. It was possibly the

first processed convenience meal ever made and it continues to be the most popular. It's one of the few universal staples that's ready-to-eat and doesn't require any additional preparation. Bread is typically made from wheat flour, one of the most extensively consumed grain items on the planet. It's high in carbs and fat but poor in useful ingredients. Supplementing bread with beneficial additions to increase its physical and nutritional attributes has become increasingly frequent and desired as living standards and health awareness have risen (Naifu *et al.*, 2019) [6]. Flour, salt, oil and leavening agents like yeast are all frequent ingredients. The flavour, aroma, quality and texture of freshly baked bread are highly valued. Bread prepared from refined wheat flour is widely consumed around the world particularly by those in underdeveloped nations (Lodhi *et al.*, 2011) [4].

Bread is a staple food for a vast portion of the world's population. Bread products are well-known all over the world due to their reduced cost, simplicity of preparation, greater variety, appealing sensory characteristics and nutritious properties. A number of research on the milling and baking characteristics of Indian durum and bread wheat have recently been published. Bread is not only a source of energy, but also a source of many nutrients for the human body, such as proteins, dietary fibre and certain vitamins and minerals (Dina *et al.*, 2019) [2].

Due to the limited profit margins on basic breads several bakeries are attempting to differentiate and add value to their offerings. In Europe, herbal-infused breads and cakes such as carrot pomace are available on the market (Upadhyay *et al*., 2008; Vassallo *et al*., 2009) [12, 14]. (Singh *et al*., 2006) [10] Investigated the fibre and functional advantages of pearl millet in cake.

The current study aims to introduce bitter gourd into a traditional bread recipe for added health advantages. Thus a food-based approach is planned to develop bread with the incorporation of bitter gourd power.

Materials and Methods

Materials

Refined wheat flour, sugar, vansapati ghee, milk powder and salt were purchased from a local market in Parbhani, Maharashtra for the preparation of bitter gourd powder enhanced bread. Baker's yeast, calcium propionate and GMS are available at the bakery plant at College of Food Technology, VNMKV, Parbhani.

Chemicals and glassware

The analytical grade chemicals, standard reagents, indicators and microbiological media utilised in this study were obtained from the Department of Food Microbiology and Safety, Department of Food Chemistry and Nutrition and Department of Food Process Technology, College of Food Technology, VNMKV, Parbhani.

Processing and analytical equipment

Vernier calliper, Weighing balance, Grinder, Cabinet tray dryer, Digital sieve shaker, Hot air oven, Dough kneader, Dough moulder, Baking oven, Bread slicer, Soxhlet apparatus, Micro Kjeldhal unit, Muffle furnace, pH metre, Spectrophotometer, Autoclave, Incubator, Colony counter and TAXT2 plus Texture Analyzer were among the equipment and processing machineries used in the study from Department of Food Engineering, Department of Food Chemistry and Nutrition, Department of Food Microbiology and Safety, Niche area laboratory, Bakery plant and Pilot plant, College of Food Technology, VNMKV, Parbhani.

Physical properties of prepared bread

Physical properties of bread help in processing, packaging, transportation and storage. Different physical properties such as loaf weight, loaf height and loaf volume, specific volume and baking loss were determined by the methods given by (Menon *et al.*, 2015) [5].

Loaf weight

Loaf weight was measured by weighing the baked loaf mass using digital weighing balance.

Loaf height

Loaf height of baked loaf was measured with the help of vernier caliper.

Loaf volume

Volume of loaf was measured by using measuring cylinder. The prepared loaf was placed in measuring cylinder having broad neck and reading was noted in ml.

Specific volume

Specific volume of bread loaf was measured by dividing the loaf volume by loaf weight in ml/g.

Baking loss

Baking loss was measured by determining the moisture loss by weighing the freshly prepared loaf before baking and baked loaf after 1 hour in terms of yield. The baking loss was calculated in percentage as per the following formula.

$$\text{Baking loss (\%)} = \frac{\text{Loaf wt before baking (g)} - \text{Loaf wt after baking (g)}}{\text{Loaf wt before baking (g)}} \times 100$$

Proximate composition of bitter gourd powder

Bitter gourd powder samples was analysed for moisture, protein, fat, total ash, crude fibre and total carbohydrate contents according to their respective standard methods as described in (AOAC, 2000; Ranganna, 1986) [1, 8].

Mineral analysis of bitter gourd powder

5 grams of each sample was weighed in crucible and burn it on heating plate till the sample becomes fumeless. The obtained sample was placed in muffle furnace at 550°C for 5-6 hrs. The obtained ash samples were digested with concentrated Hydrochloric acid (HCL) on hot plate. The digested material was then filtered using Whatman No. 42 filter paper and the final volume made to 100ml with distilled water the obtained mineral solution was further used for analysis with respect to minerals calcium, magnesium, phosphorus, zinc, iron and copper content by using methods given by (Ranganna, 1986) [8].

Formulation of bread Incorported with bitter gourd powder

Bread enriched with bitter gourd powder was prepared with varying the composition of bitter gourd powder and refined wheat flour. The control bread sample was prepared without incorporation of bitter gourd powder. The formulation of five different trials are presented in Table 1.

Table 1: Formulation of bread

Ingredients	T_0	T_1	T_2	T_3	T_4
Bitter gourd powder (g)	0	1	2	3	4
Refined wheat flour (g)	100	99	98	97	96
Sugar (g)	4	4	4	4	4
Salt (g)	2	2	2	2	2
Yeast (g)	2.5	2.5	2.5	2.5	2.5
Vanaspati ghee (ml)	2	2	2	2	2
Water (ml)	58	58	58	58	58
GMS (g)	0.5	0.5	0.5	0.5	0.5
Calcium propionate (g)	0.5	0.5	0.5	0.5	0.5
Milk powder (g)	2	2	2	2	2

T_0 = 0 per cent bitter gourd powder
T_1 = addition of 1% bitter gourd
T_2 = addition of 2% bitter gourd powder
T_3 = addition of 3% bitter gourd powder
T_4 = addition of 4% bitter gourd powder

Preparation of bread

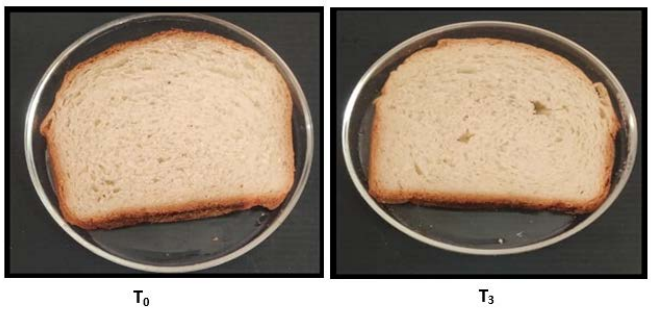
Weighing of ingredients
⇩
Flour kneading
⇩
Dough form
⇩
Bulk fermentation (Temperature 23-29°C, Humidity 70-75 %)
⇩
Scaling and dividing
⇩
Rounding and intermediate proofing (5-30 min, Temperature 26-29°C)
⇩
Moulding (sheeting)
⇩
Panning
⇩
Pan proofing (55-56 min, Temperature 29-35°C)
⇩
Baking (Temperature 210°C, 25 min)
⇩
Cooling
⇩
Slicing
⇩
Packing (HDPE packaging material)
⇩
Storage

Flow-Sheet 1: Preparation of bread

As per the recipe all ingredients were weighed. Measured yeast added in 20ml water along with sugar and kept for activation for 10 min. Then refined wheat flour, bitter gourd powder, calcium propionate, GMS, milk powder and salt were added in dough kneader and dough kneading was carried out with addition of remaining water until to achieved required consistency of dough. After kneading dough was kept for bulk fermentation at room temperature by covering it with wet muslin cloth for 1 hr scaling and dividing was done with using weighing balance. Rounding and intermediate proofing of scaled dough was done for 5-30 min at room temperature. Dough was transfer to moulder for the process of dough moulding. Greasing of pan was carried out and dough was kept for pan proofing for 1 hr with sprinkling water on the top surface. Baking of bread loaf was done at 210°C for 25 min. After baking pan removed from oven and loaf kept for cooling at room temperature for 1hr. Then slicing was carried out by using bread slicer. Prepared bread packed in HDPE packaging material.

T_0 T_3

(A) Control bread (T_0) and selected bread (T_3) loaf



T_0 T_3

(B) Control bread (T_0) and selected bread (T_3) slices

Textural profile analysis.

A compression test was used to do an instrumental TPA test which generated a plot of force (N) against time (s) using a texture analyser with a 5 kg load cell. The analyser was connected to a calculator which used a software programme to capture data. Textural characteristics were measured using a P/36 R cylindrical probe. With a pre-test speed of 2 mm/s and a post-test speed of 10 mm/s, the prepared bread samples were taken and compressed up to 60% of their original height. Textural parameters were calculated using the data provided from the TPA curve (hardness, fracturability, cohesiveness, springiness and chewiness).

Results and discussion

Physical properties of control and selected bread

The physical properties such as loaf weight, loaf height, loaf volume, specific volume and baking loss were evaluated. Obtained results are presented in the Table 2.

Table 2: Physical properties of control and selected bread

Parameters	Control bread (T_0)	Selected bread (T_3)
Loaf weight (g)	253.66±2.08	258.66±2.51
Loaf height (cm)	7.10±0.12	5.83±0.3
Loaf volume (ml)	662.42±3.25	627.59±3.77
Specific Volume (ml/g)	4.56±0.25	3.63±0.30
Moisture content (%)	29.52±0.90	30.63±0.23
Baking Loss (%)	32.37±0.68	25.56±2.83

*Each value represents the average of ten determinations

The loaf weight of control and selected bread was 253.66 and 258.66g respectively. Loaf height of control bread sample was 7.10cm and for selected bread it was 5.83cm. There was difference found in the loaf volume of control and experimental bread. The loaf volume of control bread was 662.42 ml whereas the loaf volume of selected bread was 627.59 ml. Decrease in loaf height and volume of selected bread was due to the incorporation of bitter gourd powder. Specific volume of control and selected bread was 4.56 and 3.63 ml/g respectively. Moisture content of control and selected bread was 29.52 and 30.63% respectively. Baking loss in control bread was 32.37% and 25.56% in selected bread. Obtained results for the physical properties of control bread found to be in close agreement with the result reported by (Menon *et al*., 2015) [5].

Proximate composition of control and selected bread

The proximate constituents of food commodities help in determining the nutritional profile of food products. The average proximate constituents such as moisture, carbohydrate, protein, fat and ash content was determined for control and selected bread sample. The obtained results are presented in the Table 3.

Table 3: Proximate composition of control and selected bread

Parameters (%)	Control bread (T_0)	Selected bread (T_3)
Moisture	29.52±0.90	30.63±0.23
Carbohydrate	54.35±0.36	51.56±0.83
Protein	6.19±0.2	7.05±0.45
Fat	6.98±0.3	6.31±0.3.
Ash	1.67±0.2	1.73±0.25
Fiber	1.27±0.9	2.72±0.14

*Each value represents the average of ten determinations

Data obtained from the Table 3 showed the impact of incorporation of bitter gourd powder on proximate constituents of bread. The moisture content of control and selected bread sample was 29.52 and 30.63% respectively. Carbohydrate content of control bread was 54.35% and selected bread was 51.56%.

It was narrated that the carbohydrate content of selected bread was decreased with exploration of bitter gourd powder by replacing refined wheat flour. Obtained results for carbohydrate content of control bread sample was found to be similar with the results reported by (Ruiz-Ruiz *et al.*, 2015) [9]. Protein and fat content of control bread was 6.19 and 6.98% respectively. Selected bread sample contains 7.05% protein and 6.31% fat. The values of protein and fat content of selected bread was found to be slightly higher than of control bread sample. The obtained results for the protein and fat content of bread found to be in close agreement with the results reported by (Zambelli *et al.*, 2017) [15]. The ash content of control and selected bread sample was 1.67 and 1.73% respectively. Fiber content of control bread was 1.27% and selected bread sample was 2.72%. Increase in the fiber content of prepared bread was observed due to the incorporation of bitter gourd powder.

Mineral composition of control and selected bread

Minerals play an important role in regulation of various body processes. Minerals such as calcium, potassium, magnesium, iron and zinc for control and selected bread were evaluated. The obtained results are presented in Table 4.

Table 4: Mineral composition of control and selected bread

Parameters	Values (mg/100g)	
	Control bread (T_0)	Selected bread (T_3)
Calcium	79.18±0.64	80.81±0.53
Potassium	215.00±0.53	216.6±0.74
Magnesium	24.68±0.43	25.94±0.15
Iron	2.49±0.34	2.98±0.55
Zinc	1.64±0.42	1.83±0.55

*Each value represents the average of ten determinations

The obtained data from the Table 4 for mineral composition revealed that the selected bread was a good source of minerals with compare to the control. It was found the mineral composition of control bread sample was calcium (79.18mg), potassium (215.00mg), magnesium (24.68mg), iron (2.49mg) and zinc (1.64mg) respectively. The mineral composition of selected bread was calcium (80.81mg), potassium (216.6mg), iron (2.98mg), magnesium (25.94mg) and zinc (1.83mg) respectively.

Results for the mineral composition such calcium, iron and zinc found to be in close agreement with the study carried out by (Lalit & Kochhar, 2017) [3]. Obtained results for the mineral composition revealed that prepared bread was good source of potassium, calcium and magnesium.

Textural analysis of control and selected bread

A texture analysis is primarily concerned with measurement of the mechanical properties of a product. Texture analyzer performs this test by applying controlled force to the product and recording its response in the form of force, deformation and time. Hardness is the force necessary to attain a given deformation of the material or it is the force required to bite through the sample. Texture of bread was measured using *TA XT2* texture analyser (stable micro system) within 24 hours after preparation. The results of texture analysis of bread are presented in Table 5.

Table 5: Textural analysis of prepared bread

Parameters	Observations	
	Control bread (T_0)	Selected bread (T_3)
Hardness (kg)	1.061	0.848
Cohesiveness	0.93	0.66
Gumminess (kg)	0.986	0.559
Springiness	1.054	1.043
Adhesiveness (kg/sec)	-0.002	-0.003

Result obtained from the Table 5 narrated that incorporation of bitter gourd powder decrease in hardness. Hardness of control sample was 1.061kg whereas for selected sample it was 0.848kg. Cohesiveness and springiness of control sample was 0.93 and 1.054 respectively and for selected sample it was 0.66 and 1.043 respectively. Gumminess of bread is based on hardness and cohesiveness. Gumminess of control and selected sample was 0.986 and 0.559kg respectively. The obtained results for gumminess and cohesiveness were found to be closely agreement with the results reported by (Ranawana *et al.*, 2016) [7].

Adhesiveness of control and selected bread was -0.002 and -0.003 kg/sec. The obtained study concluded that with decreasing value of hardness there was also decrease in the values of cohesiveness, gumminess, springiness and adhesiveness with compare to control sample. Study revealed that prepared bread with incorporation of bitter gourd powder having the good texture profile. Textural study of bread was found to be significant with compare to the results obtained by (Valerga *et al.*, 2020) [13].

Conclusion

The present study focuses on preparation of bread with incorporated of bitter gourd powder. The process of bread preparation was standardized by varying the concentration of refined wheat flour and bitter gourd powder. On the basis of organoleptic evaluation the sample T_3 was selected. It was found that the addition of 3% of bitter gourd powder found to be acceptable with sensory parameters. The obtained results revealed that the prepared bread sample was good source of carbohydrate, protein and fat. The selected sample was found to be good source of minerals such as calcium, potassium and magnesium. Hence it is finally concluded that prepared product having the good nutritional profile. Utilization of bitter gourd powder for the development bakery food product helps to enhance the nutritional content and health benefits. This type of product development technology helps to improve the market and statistics of bakery industries.

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