

Development and standardization of functional bread fortified with bitter gourd (*Momordica charantia*) powder

ABSTRACT

The study of bread development was carried out at the department of food technology, Parul university, Vadodara. The present study focuses on preparation functional bread incorporation of bitter gourd powder. The process of bread preparation was standardized by varying the concentration of wheat flour and bitter gourd powder. Innovation in bread production and the inclusion of useful ingredients are essential for the development of functional foods. The greatest processed food industry in India is the bread industry, and the nation's production is continually rising. *Momordica charantia* (Cucurbitaceae) is a tropical shrub with yellow blooms and green foliage. Bitter gourd has antidiabetic ingredients such as charantin, vicine, and polypeptide-p as well as other generic bioactive ingredients like antioxidants. On the basis of Sensory evaluation, the sample T5 was selected. It was found that the addition of 8% of bitter gourd powder found to be acceptable with sensory parameters. The present investigation was carried out to study the physical and chemical characteristics of bitter gourd bread. The average proximate constituents such as moisture, carbohydrate, protein, fat, fiber and ash content were determined of bread which is 33 per cent, 74.69 per cent, 11.92 per cent, 5.22 per cent, 4.37 per cent and 3.8 per cent respectively. The Fourier transform infrared spectroscopy (FT-IR) of bitter gourd powder bread showed the presence of spectra 3261.63 cm^{-1} which represent O-H group, 2934.40 cm^{-1} are observed which showed C-H group, 1641.04 cm^{-1} represent C=C group and 1077.89 cm^{-1} represent C-O group. Minerals such as calcium, magnesium, iron and zinc of bread were evaluated. The minerals were calcium (16.0mg), iron (9.59mg), magnesium (14.81mg) and zinc (3.23mg) respectively. The obtained results revealed that the prepared bread sample was good source of carbohydrate, protein, fiber and fat. The selected sample was found to be good source of minerals such as calcium, iron, Zinc and magnesium. Total energy obtained in bitter gourd powder-based bread was 242.82 Kcal/ 100gm. TPC (Total plate count) 7400 cfu/g was observed at refrigeration temperature after 7 days. Bitter gourd powder-based bread was packed in, polyethylene pouches (PEP), and stored under ambient (18-38 °C) and refrigerated (4-7 °C) temperature conditions for 7 days and it was observed that the overall increase in moisture content at ambient temperature of wheat and bitter gourd powder bread ranged from 33.00 to 33.57 per cent whereas, the overall decrease in protein and fat ranged from 11.92 to 11.52 per cent and 5.22 to 4.65 per cent, respectively. The overall increase in moisture content at refrigeration temperature of wheat and bitter gourd powder bread ranged from 33.00 to 33.24 per cent whereas, the overall decrease in protein and fat ranged from 11.92 to 11.74 per cent and 5.22 to 4.82 per cent, respectively. The Moisture increases more at ambient temperature as compared to refrigeration temperature. Whereas the overall decrease in

protein and fat is more in ambient temperature compare to refrigeration temperature. So, refrigeration temperature is more effective for storage than ambient temperature 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. The objective of the **current study is to improve the health benefits of a traditional bread recipe by including bitter gourd. As a result**, it is intended to make bread using a food-based approach and bitter gourd power.

Keywords- Bitter Gourd, FT-IR, antidiabetic, functional bread, Total plate count

1. INTRODUCTION

The food industry is one of the most significant industries since it is in charge of processing agricultural raw materials and providing food (Bigliardi and Galati, 2013). Bakery goods are important processed food enterprises in the globe, with a vast range of products, making it the food industry's largest subzone. A huge increase in global bakery output over the previous decade has resulted in the production of much more biscuits, cakes, muffins, wafers, and other bakery items. (Lassoued *et al.*, 2008). The popularity **of bread in society is rising, and sales in the bakery sector have been seen to be steadily rising. Innovation in bread production and the inclusion of useful ingredients are essential for the development of** functional foods. The greatest processed food industry in India is the bread industry, and the nation's production is continually rising. The two most popular bakery items are bread and biscuits, which make up around (82%) of overall sales (Somayeh *et al.*, 2012).Wheat flour, one of the most widely eaten grains on the globe, is primarily used to make bread. It has few beneficial elements but is heavy in fat and carbohydrates. Bread supplementation to improve its physical and nutritional qualities has grown more common and sought as living standards and health awareness have increased (Naifu *et al.*, 2019).Ingredients that are frequently used include flour, salt, oil, and leavening agents like yeast. Freshly made bread is widely prized for its flavour, fragrance, quality, and texture. Bread made from refined wheat flour is extensively consumed worldwide, especially by people in developing **countries. One of the most intriguing breakthroughs is the creation of novel functional meals (Lodhi *et al.*, 2011).**

Consuming bitter gourds in a variety of forms, including whole fruit, juice, extract, and dry powder, has been demonstrated in several trials to help lower blood glucose levels (Basch *et al.*, 2003 and Lawrence *et al.*, 2009). It has hypoglycemic characteristics due to the presence of glycosides, saponins, alkaloids, triterpenes, polysaccharides, proteins, steroids, momordin Ic, charantin, a polypeptide-p, and oleanolic acid 3-O-monodesmoside and oleanolic acid 3-O-glucuronide (Ali *et al.*, 1993). In compared to non-insulin-dependent diabetic mellitus rats, insulin-dependent diabetes

mellitus rats and normal rats had a significant hypoglycemic effect in fasting and post-prandial stages after drinking the saponin-free methanolic extract of bitter gourd juice. Bitter gourd improves glucose tolerance, lowers postprandial hyperglycemia, and increases insulin sensitivity and lipolysis in rats (Uebanso *et al.*, 2007 and Leung *et al.*, 2009). Bitter gourd contains a substantial quantity of protein, minerals, vitamins, and polysaccharides and are very nutrient-dense (Aziz *et al.*, 2011). Many diabetes people consume bitter gourd juice in the morning as a natural cure since it has been demonstrated to have hypoglycemic action (Sitasawad *et al.*, 2000). Diabetes mellitus (DM) is a condition of excessively high blood sugar levels or hyperglycemia that is often brought on by a combination of inherited and environmental factors (Leu and Zonszein, 2010). A serious issue with world health is diabetes mellitus. Concern is being expressed throughout the world because to the increase in prevalence from 171 million in 2000 to 366 million in 2030 (Shaw *et al.*, 2010). Freeze dried gourd flesh was rich in lysine compared to soy protein isolate. Arginine and glutamic acid levels in the flesh were not particularly high. Threonine, valine, methionine, isoleucine, leucine, and phenylalanine are essential amino acids that are present in amounts similar to those of soy and other legume proteins (Islam *et al.*, 2005). Fresh bitter gourd is a good source of vitamin-C (100 g of raw pod offers 84 mg or around 140 per cent of RDA) (100 g of raw pod provides 84 mg or about 140 per cent of RDA). Vitamin-C, one of the greatest natural antioxidants, supports the body in scavenging detrimental free radicals. The vitamin C concentration of bitter gourd is its main nutritional advantage (Balasubramanian *et al.*, 2007).

Bitter gourd is a rich source of health beneficial flavonoids such as β -carotene, α -carotene, lutein, and zeaxanthin. It also includes a significant quantity of vitamin A, which serves as a protective scavenger against reactive oxygen species (ROS) and oxygen-derived free radicals, both of which contribute to ageing, cancer, and other disease processes. Although if the nutritional value of minerals in one cup of bitter melon is not nearly as great as that of vitamins, it still has some nutritious value. The most prevalent mineral found is potassium, with 275 mg or 8 percent of the daily value. According to the University of Maryland Medical Centre, potassium is important for the efficient functioning of the cardiac muscle, electrical impulses, muscular contractions, cells, tissues and digestive system (Sathishsekar, 2005). According to research from the University of California at San Francisco, just about half of American people consume the 25–30 mg of fibre per day that is advised. One cup of bitter gourd has 2.6 g of fibre, which is around 10 per cent of the daily requirement. Even if the amount of fibre may appear to be negligible in comparison to the vitamin and mineral content (Jiratchariyakul *et al.*, 2001). *M. charantia* leaf extracts (methanol and ethanol) have shown a wide range of antibacterial activity in both clinical and experimental settings (Braca *et al.*, 2008).

There are some toxic effects of bitter gourd in health such as bitter gourd has been shown to reduce blood glucose levels. The proposed mechanisms include insulin-like actions, stimulation of pancreatic insulin secretion, reduction of hepatic gluconeogenesis, enhanced hepatic glycogen synthesis, and

improved peripheral glucose oxidation (Lancet, 2000). After drinking bitter gourd tea, two cases of hypoglycemic coma and convulsions in youngsters were observed (Jayasoorya *et al.*, 2000). A poisonous lectin found in bitter gourd seeds and outer rind prevents the gut wall from producing proteins. Yet, there is no correlation between this with clinical symptoms or indications in people (Sultana and Bari, 2003). After consuming bitter melon seeds, those who lack the enzyme glucose-6-phosphate dehydrogenase run the risk of developing favism (Semiz and Sen 2007). Animals that were given bitter gourd fruit juice and seed extract orally showed significant increases in γ -glutamyl transferase and alkaline phosphatase (Semiz and Sen 2007). Bitter gourd overconsumption may result in moderate stomach ache or diarrhoea. If diabetics regularly drink bitter gourd while taking hypoglycemic medications, they will need to change the dosage of their medications. Bitter gourd or its juice should not be consumed in excess by pregnant women as it may stimulate the uterus and cause uterine tightness and premature labour. (Leu and Zonszein, 2010). The bitter gourd has a lot of the two features emmenagogue and an abortifacient. Those who suffer from ulcers and heartburn should avoid drinking bitter gourd tea since it might make their symptoms worse (Sultana and Bari, 2003) and According to Panda and Kar (2000), while T3 was increased by an alcoholic extract of *Momordica charantia* fruits, T4 was decreased. *M. Charantia* fruit extract, when taken in excess, may show to be hazardous with regard to thyroid function and lipid peroxidation since two higher dosages suppressed thyroid hormone concentrations and increased hepatic lipid peroxidation.

Wheat is a valuable source of natural antioxidants and dietary fibre (Nidhi *et al.*, 2021). The temperate region's main crop, wheat, is farmed from 67° N in Scandinavia and Russia to 45° S in Argentina (Feldman, 1995). Gluten is the primary wheat protein responsible for the ability of wheat flour to make dough and is the secret of wheat's exceptional capacity to fit the manufacturing of leavened goods. According to their role in the wheat grain, the proteins that make up gluten are storage proteins (Shewry, 1999). The protein residue left behind when separating maize starch is known as gluten in the commercial world (Patil, 2003 and Patil, 2004).

In this research FT-IR is used for analysis of functional properties of product. Fourier Transform Infrared Spectroscopy (FT-IR) light is absorbed by the vibrational motion of the molecule in infrared (IR) absorption spectroscopy, a kind of vibrational spectroscopy. Without the need for separate scanning, quick and high-resolution spectra are acquired for each wavelength. The results of even tiny samples can be obtained quickly. Food engineering uses a variety of scientific disciplines for tasks such microbial cell identification, macromolecule structural analysis, qualitative and quantitative analysis of organic materials, structural identification, stereochemistry structure determination, and purity control. (Büyüksırt and Kuleaşan, 2014).

So, these studies were carried out to develop Bitter gourd powder-based bread.

2. Material and methods

The present investigation entitled “**Development and standardization of functional bread fortified with bitter gourd (*Momordica charantia*) powder**” was conducted under different experiments in the Department of Food Technology, Parul Institute of Applied Sciences, Parul University, Vadodara, Gujarat, India

2.1. Procurement of raw materials

Wheat flour was purchased from local market of Vadodara. The wheat flour was collected randomly and brought to the laboratory for carrying out the present study. Bitter gourd powder was developed in laboratory by using mechanical cabinet air dryer. The other ingredients were purchased at the Vadodara local market, including Salt, Yeast, oil and plastic pouches, containers whereas other materials such as utensils, weighing balance etc.

2.2. Experiment details

The present research was focused on the Development of sugar free bitter gourd powder-based bread. The whole investigation was divided into various experiments and sub-experiments. The experiments details are given below:

2.2.1. Preparation of bread

Wheat flour, bitter gourd powders, oil, salt, yeast and water were the different ingredients used for the preparation of bread. Different combinations of the ingredients were tried. Yeast was added to lukewarm water and keeps it 10 min for activation. After that the flour, vegetables powder and salt mix properly. The activated yeast was added and to flour and flour was kneaded into dough with fat and required amount of water. Further, the dough kept for 1 h. Kneading was done again followed by fermentation for 2 h. Dough was further added to container and proofing was done for 30 min. It was baked in pre-heated oven at 150⁰C for 30 min.

2.2.2. Packaging and storage

The best treatment/ combination was selected by the sensory evaluation for further studies. The best treatment from blend was selected and further packed in polyethylene pouches (0.75 mm gauge) and stored at refrigerated and ambient condition. The breads were analysed for various physico-chemical and sensory parameters at different interval of 0, 3, 5 and 7 days of storage.



Dry ingredients



Addition of yeast in Lukewarm water



Addition of dry ingredients



Mixing of dry ingredients



Greasing of baking mold



Kneading was done again and kept for fermentation (2h)



Kneading of dough and kept for 1h



Addition of Activated Yeast





Figure 1 Unit operation for development of sugar free Bitter gourd powder Bread

2.3. Standardization of proportion of blends

Table 1 reflects the proportion of bitter gourd powder were used for development of functional bread. The blends were standardized on the basis of sensory evaluation of 9-point Hedonic rating scale.

Table 1 Standardization of proportion of blends (Wheat flour and bitter gourd powder)

Treatments	Wheat flour (gm)	Bitter gourd powder (gm)	Yeast (gm)	Salt (gm)	Oil (ml)
T ₀	100	-	10	5	10
T ₁	98	2	10	5	10
T ₂	96	4	10	5	10
T ₃	95	5	10	5	10
T ₄	93	7	10	5	10
T₅	92	8	10	5	10
T ₆	90	10	10	5	10
T ₇	88	12	10	5	10
T ₈	87	13	10	5	10
T ₉	86	14	10	5	10
T ₁₀	85	15	10	5	10
T ₁₁	84	16	10	5	10
T ₁₂	82	18	10	5	10
T ₁₃	80	20	10	5	10
T ₁₄	78	22	10	5	10
T ₁₅	76	24	10	5	10
T ₁₆	75	25	10	5	10
T ₁₇	74	26	10	5	10
T ₁₈	72	28	10	5	10
T ₁₉	71	29	10	5	10
T ₂₀	70	30	10	5	10

2.4. Chemical, functional and sensory analysis

Moisture, Ash, Fiber, Total plate count and carbohydrate were determined as per method explained by Ranganna. (2009). Protein and fat were determined according to the procedure mentioned in AOAC (2012). Energy value is measured by bomb calorimeter as procedure mentioned in Phillipson

(1964). Mineral content was determined by Rajsekaran *et al.* (2005). Fourier Transform-Infrared Spectroscopy was determined as per method of Stuart (2005). Nine-point hedonic scale for sensory evaluation were determined as per method explained by Amerine *et al.* (1965).

3. Result and Discussion

The present investigation entitled “**Development and standardization of functional bread fortified with bitter gourd (*Momordica charantia*) powder**” was conducted under different experiments in the Department of Food Technology, Parul Institute of Applied Sciences, Parul University, Vadodara, Gujarat, India during the years 2021-2022. The results of the study are presented and discussed under different heads and sub-heads:

3.1. Standard formulation used for the preparation of bread

Table 2 indicated the standardized blends of bitter gourd powder and wheat flour selected for the development of bread on the basis of sensory evaluation (9-point Hedonic rating scale) for further study. Out of 20 treatments, the panel of judges—faculty members, including the dean—and post-graduate students from the department of food technology chose T5 as the best one.

Table 2 Standard formulation used for the preparation of bread

Ingredients	Composition (g)
Wheat flour	92
Bitter gourd powder	8
Fat (Refined oil)	10
Salt	5
Yeast	10

3.2. Chemical and functional properties of bread

The trials were conducted for the analysis of bitter gourd powder-based bread, moisture per cent, protein per cent, carbohydrate per cent, fibre per cent, ash per cent, Fat per cent, energy value Kcal, FTIR analysis, Ca per cent, Mg per cent, Fe mg/ 100 g and Zn mg/ 100 g. These all analysis are done for bitter gourd powder-based bread at both ambient and refrigeration temperature.

3.2.1. Chemical analysis

The data presented in Table 3 and Table 4 showed the proximate composition and mineral composition of bitter gourd powder-based bread respectively and the physico-chemical parameters of bread is presented and discussed under the following heads and sub-heads

Table 3 Proximate composition of bread

S.no.	Parameters	Amount (%)
1	Protein	11.92
2	Fat	5.22
3	Fiber	4.37
4	Carbohydrate	74.69
5	Moisture	33
6	Ash	3.8
7	Energy value	242.82 Kcal/100gm

Table 3 represented bitter gourd powder-based bread had 11.92 per cent protein, 5.22 per cent fat, 4.37 per cent fibre, 74.69 per cent carbohydrate, 33 per cent moisture, 3.8 per cent ash and Total energy obtained was 242.82 Kcal/ 100gm respectively. Gangakhedkar *et al.*, (2021) who reported similar range of proximate composition of bitter gourd powder-based bread.

Table 4 Mineral composition of bread

S.no	Minerals	Amount (mg/100gm)
1	Ca	16.0
2	Fe	9.59
3	Zn	3.23
4	Mg	14.81

The obtained data from the Table 4 for mineral composition revealed that the bitter gourd powder-based bread was a good source of minerals. It was found the mineral composition of bread sample was calcium (16.0mg), magnesium (14.81mg), iron (9.59mg) and zinc (3.23mg) respectively. Gangakhedkar *et al.*, (2021) who reported similar range of mineral composition of bitter gourd powder-based bread.

3.2.2. Functional analysis

3.2.2.1 Fourier Transform – Infrared Spectroscopy (FT-IR) analysis

Fourier Transform Infrared spectroscopy (FT-IR) is a spectral Measurement method with long-wave infrared radiation that records absorbance in a time field and converts it to a frequency field using the Fourier transform algorithm. FTIR has been used to analyse a variety of samples due to its ability to identify functional groups of chemical compounds, such as carbohydrates, esters, as well as the chemical bonds between atoms.

The results obtained in figure 2 Shows FT-IR spectra 3261.63 cm^{-1} which represent O-H group, 2934.40 cm^{-1} are observed which showed C-H group, 1641.04 cm^{-1} represent C=C group and 1077.89 cm^{-1} represent C-O group in the bitter gourd powder-based bread. Similar observation has been recorded by Torkamani *et al.*, (2018) and Khan *et al.*, (2019).

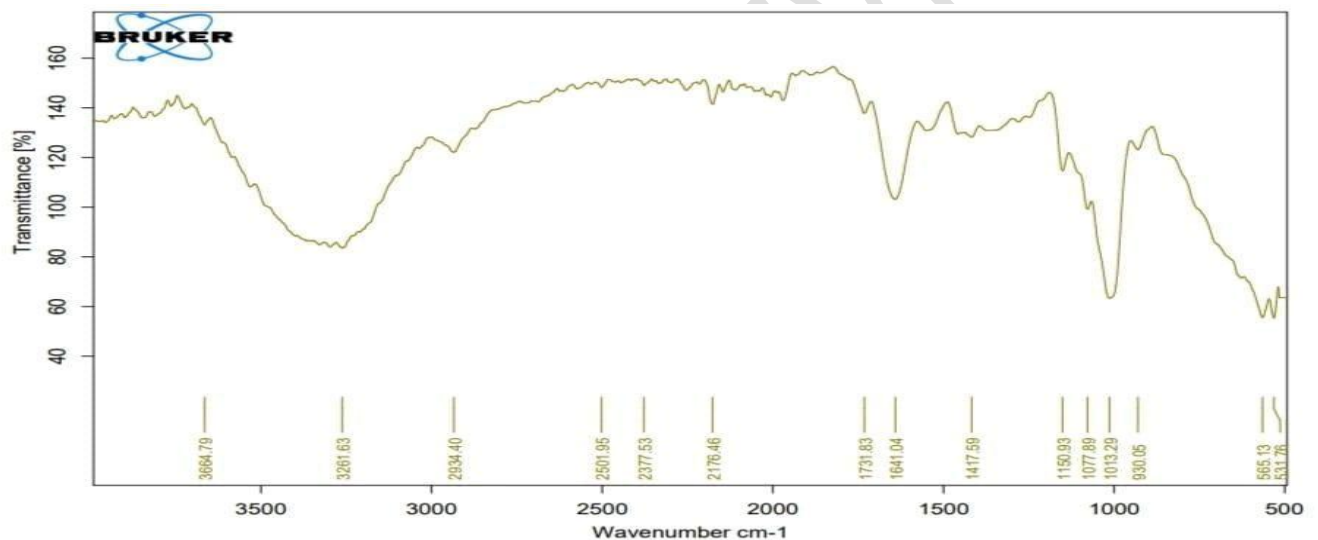


Figure 2 FT-IR analysis peaks of bitter gourd powder-based bread

3.3. Quality evaluation of bitter gourd powder-based bread during storage

3.3.1. Storage study of bitter gourd powder-based bread at ambient temperature and refrigeration temperature

The developed bread was packed in polyethylene and stored under refrigeration condition ($4\text{ }^{\circ}\text{C}$) and ambient condition ($18\text{-}38\text{ }^{\circ}\text{C}$). Bread could be stored only for 7 days and are evaluated for their nutritional quality during storage. The breads were analysed for various chemical and sensory parameters at different interval of 0, 3, 5 and 7 days of storage.

Table 5 Storage study at ambient temperature (%)

S.No.	0 Day	3 Days	5 Days	7 Days
Moisture	33.00	33.12	33.45	33.57
Protein	11.92	11.82	11.64	11.52
Fat	5.22	5.07	4.84	4.65

Table 6 Storage study at refrigeration temperature (%)

S.No.	0 Day	3 Days	5 Days	7 Days
Moisture	33.00	33.05	33.14	33.24
Protein	11.92	11.82	11.80	11.74
Fat	5.22	5.12	4.94	4.82

3.3.1.1. Moisture (%)

The data presented in Table 5 and Table 6 ambient and refrigeration temperature respectively elucidated that there was overall increase in moisture content of bitter gourd powder-based bread. There was a non-significant storage condition on moisture content of the bread during storage. The bread stored in ambient condition had higher increase from 33.00 to 33.57 per cent than that the stored at refrigerated condition from 33.00 to 33.24 per cent. The hygroscopic nature of bread likely contributed to the increase in moisture content during storage. Jood *et al.* (2016) found almost identical results.

3.3.1.2 Protein (%)

The data appended in Table 5 and Table 6 reflects the effect of storage on protein content of bread at both ambient and refrigeration temperature respectively which indicates that there was an overall decrease in protein content of bread during storage period of 7 days. There was non-significant effect of storage condition on protein content of the bread during storage. The bread stored in ambient condition had higher decrease from 11.92 to 11.52 per cent than refrigerated condition from 11.92 to 11.74 per cent. Protein loss during storage could be due to the hydrolysis of peptide bonds by protease enzymes, which causes protein molecules to divide. The findings are consistent with those of Wani and Sood (2014).

3.3.1.3 Fat (%)

The critical observation of the data in Table 5 and Table 6 indicated that there was an overall decrease in fat content in both ambient and refrigeration temperature respectively during storage period of 7 days. There was non-significant effect of storage condition on the fat content of the bread during

storage. The bread stored at ambient condition had higher decreases from 5.22 to 4.65 per cent fat content than that of stored in refrigerated condition from 5.22 to 4.82 per cent of fat content. The loss of fat content in bread could be due to triglyceride hydrolysis during storage. The findings are similar to those of Masih *et al.* (2014) and Divyashree *et al.* (2016)

3.4. Microbial Examination of Bitter gourd powder-based bread

Total Plate Count of bitter gourd powder-based was observed 7400cfu/g at refrigeration temperature after 7 days of storage. Based on this observation, it was concluded that the bread is microbiologically recommended to consume up to 7th days at refrigeration temperature.

3.4. Cost of production of bitter gourd powder-based bread

Table 7 Cost of production of bitter gourd powder-based bread

S.No.	Particular	Rate Rs.	Rate Rs.	Quantity	Amount Rs.
1	Wheat Flour	45/kg	4.5/100gm	92gm	4.14
2	Bitter gourd powder	33.28/kg	3.3/100gm	8 gm	0.264
3	Yeast	1000/kg	100/100gm	10gm	10
4	Salt	20/kg	2/100gm	5gm	0.1
5	Oil	140/kg	14/100gm	10gm	1.4
6	Packaging Material	0.5/pouch	0.5	1 pouch	0.5
7	Processing cost	@ 10% of total cost	-	-	1.64
8	Total Cost (100gm)	-	-	-	18.04

The cost incurred in preparation of bitter gourd powder-based bread was calculated by taking into consideration the cost of all inputs. The processing cost and other expenses including depreciation are added to the total expenditure. The sale price per 100 g of the products was calculated after adding 10 per cent processing cost. The cost of bitter gourd powder was calculated manually in lab as per their raw materials. The data represented in Table 7 for bitter gourd powder-based bread. The cost of bread is 18.04 /100 gm.

Conclusion

The research investigation entitled “**Development and standardization of functional bread fortified with bitter gourd (*Momordica charantia*) powder**” was carried out in the Department of Food Technology, Parul Institute of Applied Sciences, Parul University, Vadodara, Gujarat, India during 2021-2022. To accomplish the study's goal, a series of painstakingly performed experiments were standardised and performed in order. The findings of the present investigation have been succinctly stated and concluded as follows:

The developed bread packed in polyethylene and stored under refrigeration condition (4 °C) and ambient condition (18-38 °C). Bread could be stored only for 7 days and are evaluated for their nutritional quality during storage. The overall increase in moisture content at ambient temperature of wheat and bitter gourd powder bread ranged from 33.00 to 33.57 per cent whereas, the overall decrease in protein and fat ranged from 11.92 to 11.52 per cent and 5.22 to 4.65 per cent, respectively. The overall increase in moisture content at refrigeration temperature of wheat and bitter gourd powder bread ranged from 33.00 to 33.24 per cent whereas, the overall decrease in protein and fat ranged from 11.92 to 11.74 per cent and 5.22 to 4.82 per cent, respectively. The Moisture increases more at ambient temperature as compared to refrigeration temperature. Whereas the overall decrease in protein and fat is more in ambient temperature compare to refrigeration temperature. During the FT-IR analysis we observed spectra 3261.63 cm^{-1} which represent O-H group, 2934.40 cm^{-1} was observed which showed C-H group, 1641.04 cm^{-1} represent C=C group and 1077.89 cm^{-1} represent C-O group in the bitter gourd powder-based bread. Total Plate Count of bitter gourd powder-based was observed 7400cfu/g at refrigeration temperature after 7 days of storage. Based on this observation, it was concluded that the bread is microbiologically recommended to consume up to 7th days at refrigeration temperature. The cost incurred in preparation of bitter gourd powder-based bread was calculated by taking into consideration the cost of all inputs. The processing cost and other expenses including depreciation are added to the total expenditure. The sale price per 100 g of the products was calculated after adding 10 per cent processing cost. The cost of bread is 18.04 /100 gm was calculated.

References

Ali L, Khan A K, Mamun, M I, Mosihuzzaman M, Nahar N, Nur-ealam M and Rokeya B, (1993), Studies on hypoglycemic effects of fruit pulp, seed, and whole plant of *Momordica charantia* on normal and diabetic model rats. *Planta Medica*, 59: 408-12

Amerine M A, Roessler E B and Ough C S, (1965),The effect of pH and titratable acidity. *American Journal of Enology and Viticulture*,16: 29-37.

AOAC. (2012). Official Methods of analysis of AOAC International 19th ed. Gaithersburg, Washington DC, USA.

Aziz, M.G, Roy, J., Sarker, M.S.H. and Yusof, Y.A. (2011). Isolation and use of bitter gourd polysaccharide in formulating dietetic soft drinks. *African Journal of Agricultural Research*, 6(23), 5313-5319

Balasubramanian, G., Sarathi, M., Kumar, S.R. and Hameed, A.S.S., (2007) Screening the antiviral activity of Indian medicinal plants against white spot syndrome virus in shrimp. *Aquaculture*,263 (1): 15–19

Basch E, Gabardi S and Ulbricht C. (2003), Bitter melon (*Momordica Charantia*): a review of efficacy and safety. *American Journal of Health-System Pharmacy*, 60:199-204.

Bigliardi B and Galati F. (2013). Innovation trends in the food industry: The case of functional foods. *Trends in Food Science and Technology*, 31: 118-29.

Braca A., Siciliano T., Arrigo M.D. and Germano, M.P. (2008). Chemical composition and antimicrobial activity of *Momordica charantia* seed essential oil. *Fitoterapia*, 79 (2): 123-125

Büyüksırt, T., & Kuleşan, H. (2014). Fourier transform infrared (FTIR) spectroscopy and utilization in food. *GIDA-Journal of Food*, 39(4), 235-241.

Divyashree K, Kumar AK, Sharma GK and Semwal AD. (2016). Development and storage stability of buckwheat-Chia seeds fortified biscuit. *International journal of food and fermentation technology*,6: 96-103.

Feldman M. (1995). Wheat. In: Evolution of crop plants Smartt J, Simmonds NW, *Longman Scientific and Technical Harlow (UK)* pp. 185-92.

Gangakhedkar P. S., Machewad G. M., Deshpande H. W., Katke S., & Hemant, M. (2021). Studies on physico-chemical characteristics and texture analysis of bread with incorporation of bitter gourd powder

Islam S. M, Jalaluddin G.O, Garner M, Yoshimoto O. and Yamakawa. (2005). Artificial shading and temperature influence on anthocyanin compositions in sweet potato (*Ipomoea batatas* L.) Leaves. *Hort Science*. 40 (1): 176-180

Jayasooriya A.P, Sakono M, Yuxizaki C., wano M., Yanmoto K. and Fukuda N. (2000). Effects of *Mormordica charantia* powder on serum glucose levels and various lipid parameters in rats fed with cholesterol-free and cholesterol-enriched diets. *J Ethnopharmacol*.72 (1-2): 331-136.

Jiratchariyakul W, Wiwat C. and Vongsakul M. (2001). "HIV inhibitor from Thai bitter gourd". *Planta Med.*,67: 350–3

Jood, schofield JD, Tsiami AA, Bollecker S. (2016). Effect of glutenin sub fractions on bread making quality of wheat. *International journal of food science and technology*, 36: 573-84.

Khan, M. F., Abutaha, N., Nasr, F. A., Alqahtani, A. S., Noman, O. M., & Wadaan, M. A. (2019). Bitter gourd (*Momordica charantia*) possesses developmental toxicity as revealed by screening the seeds and fruit extracts in zebrafish embryos. *BMC complementary and alternative medicine*, 19(1), 1-13.

Lancet L, Birtwhistle, R., Kotecha, J., Hannah, S. and Cuthbertson, S. (2000). Anti-diabetic and hypoglycaemic effects of *Momordica charantia* (bitter melon): a mini review. *Br. J. Nutr.* 102: 1703-1708.

Lassoued N, Delarue J, Launay B and Michon C. (2008). Baked product texture: Correlations between instrumental and sensory characterization using flash profile. *Journal of Cereal Science*,48: 133-143.

Lawrence L, Richard B, Jyoti K, Susan H and Sharon C. (2009). Anti-diabetic and hypoglycaemic effects of *Momordica charantia* (Bitter melon): A mini review. *British Journal of Nutrition*, 102:1703-08.

Leu, J. P. and Zonszein, J. (2010). Diagnostic criteria and classification of diabetes in poretsky, L., (Ed) *Principles of diabetes mellitus*, second edition. Springer. New York

Leu, J. P. and Zonszein, J. (2010). Diagnostic criteria and classification of diabetes in poretsky, L., (Ed) *Principles of diabetes mellitus*, second edition. Springer. New York

Leung L, Birtwhistle R, Kotecha J, Hannah S. and Cuthbertson S. (2009). Anti-diabetic and hypoglycaemic effects of *Momordica charantia* (bitter melon): a mini review. *British Journal of Nutrition*,102:1703-08.

Lodhi L, Verma A, Chacko N, Sheikh S. (2011), Incorporation of garlic paste and flaxseeds powder in the preparation of bread using fresh and dried yeasts. *Indian Journal of Nutrition and Dietetics*;48(8):63-73.

Masih S, Iqbal Z, Arif AM, Rafiq M, Rasool G and Rashid A. (2014). Effect of linseed oil substitution on physico-chemical properties of cookies. *Journal of Agricultural research*,52: 425-

Naifu W, Yan X, Huimei C, Min Z, Yibin Z, Mingchun W. (2019). Effects of celery powder on wheat dough properties and textural, antioxidant and starch digestibility properties of bread. *Journal Food Science Technology*;13197(19):04204-04208

Nidhi, D. K., Puranik, V., & Mishra, P. (2021). Effects of extraction solvents on cultivars of wheat (PBW-154 and HD-2967) bran antioxidant properties. *Annals of Phytomedicine*, 10(2), 354-359.

Panda, S. and Kar, A. (2000). Excess use of Momordica charantia extract may not be safe with respect to thyroid function and lipid peroxidation. *Current Science*.79 (2):222-224

Patil S K. (2003). Corn processing industry co-products: Issues and challenges. Part I. *Cereal Foods World* 48:363-64.

Patil S K. (2004). Corn processing industry co-products: Issues and challenges part II. *Cereal Foods World*,49:102-4.

Phillipson, J. (1964). A miniature bomb calorimeter for small biological samples. *Oikos*, 130-139.

Rajsekaran S, Sivagananan K and Subramaniam S. (2005). Minerals contents of Aloe Vera leaf get and their role on streptokinase-induced diabetic rats. *Biological Trace Element Research*, 108: 185-95.

Ranganna S. (2009). Handbook of analysis and quality control of fruits and vegetables products.7th ed. Tata McGraw Hill Publishing Company Limited, New Delhi, India.

Sathishsekar, D. (2005). Beneficial effects of Momordica charantia seeds in the treatment of STZ-induced diabetes in experimental rats. *Biol. Pharm. Bull.*28(6): 978-983

Semiz A. and Sen A. (2007). Antioxidant and chemo protective properties of Momordica charantia L. (bitter melon) fruit extract". *Afr. J. Biotech.*6: 273-277

Shaw, J. E., Sicree, R. A. Zimmet, P. Z. (2010). Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes Res Clin Pract.*87: 4 -14.232

Sitasawad, S. L., Yogita, S., Ramesh, B., Shewade, Y. and Bhonde, R. (2000). Role of bitter gourd fruit in STZ-induced diabetic state in vitro. *J. Ethanapharmacol.* 73(1-2): 71-79

Somayeh R, Seyed M, Taghi G, Seyed HR, Seid MJ. (2014) Recent developments on new formulations based on nutrient-dense ingredients for the production of healthy functional bread: A review. *Journal Food Science Technology* ;51(11):2896-2906.

Stuart B. (2005). Infrared Spectroscopy: Fundamentals and Applications. John Wiley and Sons.

Sultana, R. S., and Bari, M.A. (2003). In vitro propagation of karla from nodal segment and short tip. *J. Bio. Sci.* 3: 1134-1139

Torkamani, A. E., Syahariza, Z. A., Norziah, M. H., Mahmood, W. A. K., & Juliano, P. (2018). Production and characterization of gelatin spherical particles formed via electrospraying and encapsulated with polyphenolic antioxidants from *Momordica charantia*. *Food and Bioprocess Technology*, 11, 1943-1954

Uebanso T, Arai H, Taketani Y, Fukaya M, Yamamoto H, Mizuno A, Uryu K, Hada T and Takeda E. (2007). Extracts of *Momordica charantia* suppress postprandial hyperglycemia in rats. *Journal of Nutritional Science Vitaminology*, 53:482-88.

Wani TA, and Sood M. (2014). Effect of incorporation of cauliflower leaf powder on sensory and nutritional composition malted wheat biscuits. *African journal of biotechnology*, 13: 1019-26.

UNDER PEER REVIEW

UNDER PEER REVIEW