Original Research Article

FORMULATION AND STANDARDIZATION OF GUJARATI SNACK (KHAKHRA) FORTIFIED WITH WHOLE UNRIPE PUMPKIN (*CUCURBITA MOSCHATA*) POWDER

ABSTRACT

The present investigation, entitled "Formulation and standardization of Gujarati snack (khakhra) fortified with whole unripe pumpkin (*Cucurbita moschata*) powder" was conducted in the Department of Food Technology, Parul University. The goal of this study was to develop khakhra fortified with whole unripe pumpkin powder. The khakhra was prepared using oats, maize and wheat flour along with developed pumpkin powder. The black pepper, cumin and carom seed powder were used as seasoning. The developed product was examined for various physicochemical attributes, including storage stability and the FT-IR procedure for the identification of functional groups which signify various bioactive compounds. The nutritional composition of khakhra obtained showed the presence of protein, fat, carbohydrates, refibre calcium, magnesium, iron and zinc content as 10.83 per cent, 13.86 per cent, 69.95 per cent, 5.34 per cent, 10.83 mg/100g, 182.65 mg/100g, 5.27 mg/100g and 2.49 mg/100g respectively. The developed khakhra was packed in polyethene and stored for 3 months under refrigeration conditions (4^{o}C) and ambient conditions (18-38^{o}C) storage studies.

KEYWORDS: Khakhra, FT-IR, Pumpkin powder, Oats flour, Maize flour

INTRODUCTION

Snacks can be considered a tiny, quick meal consumed to sate hunger during odd hours. Snacks are readily available in a variety of forms, including traditional meals and commercially processed foods. They should be avoided because they are often harmful and are poor in nutrients. Nevertheless, it can be enhanced nutritionally by adding fruits, veggies, pulses, or grains. It will provide enough vitality as well as resolve health problems. Therefore, an attempt should be made to improve the nutritional quality of the diet in these local snacks **[1]**.

Gujarati food is flavorful and diverse, reflecting the state's multicultural diversity. Its culinary customs feature a distinctive blending of flavours, colours, and textures. Gujarat is well known for its delectable snacks like khandvis, khaman, dhokla, khakhras, fadas, and chakris. One of its native crispy flatbread known as khakhra is typically offered with tea, coffee, yoghurt, butter, cheese, ghee, chutney or pickles. They are available in an array of flavours like jeera, methi, masala, pudina, and ajwain and are generally prepared from wheat flour, mat bean, and oil. It is a fresh, homemade, roasted food item that is consumed

for breakfast or as a snack. It is well-liked as a tasty snack because it needs little to no packaging, goes through no extra processing when consumed, and has a long shelf life **[2-3]**.

Food fortification (FF) is the process of adding one or more vital nutrients to food, whether or not they are naturally present, to eliminate nutrient deficiency **[4]**. Fortification has been recognised as one of the most cost-effective health interventions by the World Bank, WHO, UNICEF, MI and GAIN. Fortification of staple foods with micronutrients is currently a strategy gaining popularity in many developing nations **[5]**. As a light, crispy snack, khakhras' addition of oats, maize, and pumpkin powder will offer people who favour healthy food a new choice. *Avena sativa* L., or whole grain oats, are particularly rich in soluble fibre, beta-glucan, lipids, protein, and specific minerals. Additionally, they are an excellent provider of polyphenols (avenanthramides) **[6]**. Degreasing is used to improve the oat flour manufacturing quality and shelf life because oat flour has poor processing qualities due to its high lipid content **[7]**. The germ contains mostly tocopherols, whereas the endosperm contains tocotrienols. Oats comprise 19–30.3 mg/kg of total tocopherols **[8]**. Only oats contain low-molecular-weight hydroxycinnamoyl anthranilate alkaloids (AVAs), whose concentration varies from 2 to 289 mg/kg **[9]**. Oat beta-glucan (OBG), a viscous polysaccharide, is thought to be the primary ingredient in oats that significantly lower cholesterol **[10-11]**.

The Poaceae genus includes a significant crop called maize (*Zea mays* L.). Vitamins C, E, K, niacin, riboflavin, pantothenic acid, pyridoxine, folic acid, selenium, N-p-coumaric tryptamine and N-ferrule tryptamine. In the typical human diet, potassium, a necessary nutrient, is inadequate **[12]**. Phytochemicals like poly sterols, carotenoids like beta-carotene, xanthophylls, and phenolic substances like feluric acid and anthocyanins are all found in significant amounts in it. Zein, a prolamine that is alcohol-soluble and found in maize endosperm, is used in the pharmaceutical and nutraceutical sectors. The risk of illnesses associated with obesity, atherosclerosis, and celiac cancer is reduced by resistant starch (RS) derived from maize **[13]**.

Vegetables can be dried to produce a broader variety of nutritious foods. Pumpkin maintains its quality for one to three months after production. After being peeled, pumpkin quality degrades as a result of moisture loss, softening, colour changes, and microbial spoilage. Since they contain a lot of moisture, drying and powdering may be suitable techniques to extend their storage life **[14]**. Pumpkin powder is used as a natural colouring agent in flour and pasta mixtures, as well as in baked products like bread, cakes, and cookies, as well as in soups, seasonings, sauces, and instant noodles **[15]**.

MATERIALS AND METHODS

The present study, entitled "Formulation and standardization of Gujarati snack (khakhra) fortified with whole unripe pumpkin (*Cucurbita moschata*) powder" was conducted in the product development laboratory of the Department of Food Technology, PIAS, Parul University, Vadodara, Gujarat, India.

Procurement of raw materials

The oats flour, maize flour, wheat flour and other ingredients like salt, black pepper powder, cumin powder, carom seed powder and oil were procured from the local market of Vadodara, Gujarat. The developed pumpkin powder was taken from the product development laboratory of the Department of Food Technology.

Treatment details

The present research focused on the development of khakhra fortified with pumpkin powder. Total 20 treatments were employed to standardize the recipe.

Table 1: Standardization of treatment blends

Treatments	Oats flour (g)	Maize flour (g)	Wheat flour (g)	Pumpkin powder (g)	Refined oil (ml)	Salt (g)	Black pepper powder (g)	Cumin powder (g)	Carom seed powder (g)
T_0	-	-	100	-	15	1.2	0.5	1.5	0.70
T_1	95	5	20	10	15	1.2	0.5	1.5	0.70
T_2	**90**	**10**	**20**	**10**	**15**	**1.2**	**0.5**	**1.5**	**0.70**
T_3	85	15	20	10	15	1.2	0.5	1.5	0.70
T_4	80	20	20	10	15	1.2	0.5	1.5	0.70
T_5	75	25	20	10	15	1.2	0.5	1.5	0.70
T_6	70	30	20	10	15	1.2	0.5	1.5	0.70
T_7	65	35	20	10	15	1.2	0.5	1.5	0.70
T_8	60	40	20	10	15	1.2	0.5	1.5	0.70
T_9	55	45	20	10	15	1.2	0.5	1.5	0.70
T_{10}	50	50	20	10	15	1.2	0.5	1.5	0.70
T_{11}	45	55	20	10	15	1.2	0.5	1.5	0.70
T_{12}	40	60	20	10	15	1.2	0.5	1.5	0.70
T_{13}	35	65	20	10	15	1.2	0.5	1.5	0.70
T_{14}	30	70	20	10	15	1.2	0.5	1.5	0.70
T_{15}	25	75	20	10	15	1.2	0.5	1.5	0.70

T_{16}	20	80	20	10	15	1.2	0.5	1.5	0.70
T_{17}	15	85	20	10	15	1.2	0.5	1.5	0.70
T_{18}	10	90	20	10	15	1.2	0.5	1.5	0.70
T_{19}	5	95	20	10	15	1.2	0.5	1.5	0.70
T_{20}	-	100	20	10	15	1.2	0.5	1.5	0.70

The standardization was done using 9 points hedonic scale which provides the score based on color, texture and taste. The overall acceptability is marked with a sore between 9-1.

Preparation of khakhra

Oats flour, maize flour, wheat flour, whole unripe pumpkin powder, oil, water, black pepper powder, cumin powder and carom seed powder were used for the preparation of khakhra. First, all flour (oats, maize and wheat) were sieved and mixed. Then flour, pumpkin powder, masala mix (black pepper, cumin and carom seed powder), salt and oil were mixed properly. The soft dough was kneaded using the required amount of water. The dough was rolled into a thin round shape and was roasted on preheated iron tawa for 5-10s. Then the half-cooked khakhras were allowed to take rest for 5-10 min and again roasted on iron tawa at low flame by continuously pressing in with cloth until it turns crispy. When served, sprinkle some chat masala.

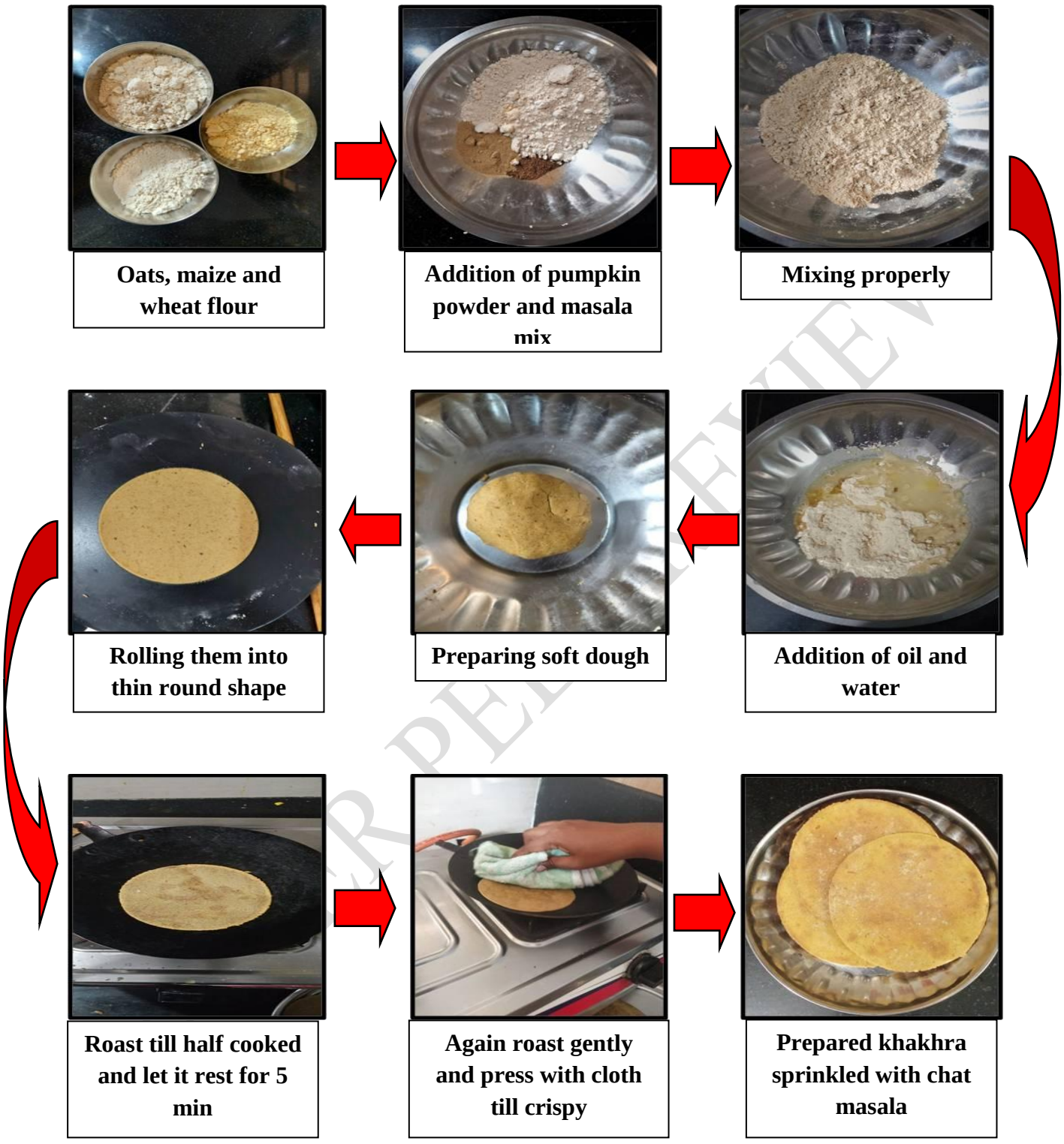

Figure 1: Preparation of khakhra

Chemical analysis

The crude protein and fat were estimated using **[16]**. The moisture, ash, crude fibre, carbohydrates and microbial evaluation were estimated by **[17]**. The dry ash method was used for mineral estimation given by **[18]**. FT-IR peaks were interpreted as per the guidelines given by **[19]**.

Storage study of khakhra

The best treatment was selected and further packed in a polyethylene bag and stored in an air tight container for 3 months at refrigeration (4ºC) and ambient (25-27ºC) temperatures. At 0, 1, 2 and 3 months of storage, the khakhras were tested for various chemical and sensory parameters.

RESULTS AND DISCUSSION

The present research, entitled "Formulation and Standardization of Gujarati snack (khakhra) fortified with whole unripe pumpkin (*Cucurbita moschata*) powder" was conducted in the product development laboratory of the Department of Food Technology, PIAS, Parul University, Vadodara, Gujarat, India.

Standardized treatment blend

Table 2: Standardized Treatment blend

Treatment	Oats flour (g)	Maize flour (g)	Wheat flour (g)	Pumpkin powder (g)	Refined oil (ml)	Salt (g)	Black pepper powder (g)	Cumin powder (g)	Carom seed powder (g)
T_2	90	10	20	10	15	1.2	0.5	1.5	0.70

After performing various treatments, T_2 was selected as the best treatment combination based on sensory evaluation done by the trained panel and institutional faculties.

Proximate composition

Various chemical parameters like ash, moisture, crude protein, crude fibre, carbohydrates and energy value were determined to understand the composition of developed khakhra.

Table 3: Chemical composition of developed khakhra

Parameters	Amount (%)
Ash	1.5
Moisture	8.2
Crude protein	10.83
Crude fat	13.86
Crude fiber	5.34
Carbohydrates	69.95

Energy value	441.90 Kcal/100g

The moisture and ash content were 8.5 per cent and 1.5 per cent respectively. These values somewhat relate to findings by **[3] [20]**. The obtained value of protein, fat, carbohydrates and fibre were 10.83 per cent, 13.86 per cent, 69.95 per cent and 5.34 per cent respectively. The energy value was calculated sing bomb calorimeter and the value obtained was 441.90 kcal/100g.

Table 4: Mineral content of khakhra

Minerals	Khakhra (mg/100g)
Calcium	10.83
Magnesium	182.65
Iron	5.27
Zinc	2.49

In khakhras, the calcium, magnesium, iron and zinc content were 10.83, 182.65, 5.27 and 2.49 mg/100g respectively. This result signifies that prepared khakhras are rich in minerals. The calcium content in khakhras closely relates to khakhras prepared from kidney bean flour **[1]**.

FT-IR analysis

Fourier Transform - Infrared Spectroscopy (FT-IR) is a spectral measurement technique with long-wave infrared radiation that captures absorbance in a time field and converts it to a frequency field using the Fourier transform algorithm. Because of its ability to identify functional groups of chemical compounds like carbohydrates, esters, and chemical bonds between atoms, FT-IR has been used to examine a wide range of samples.

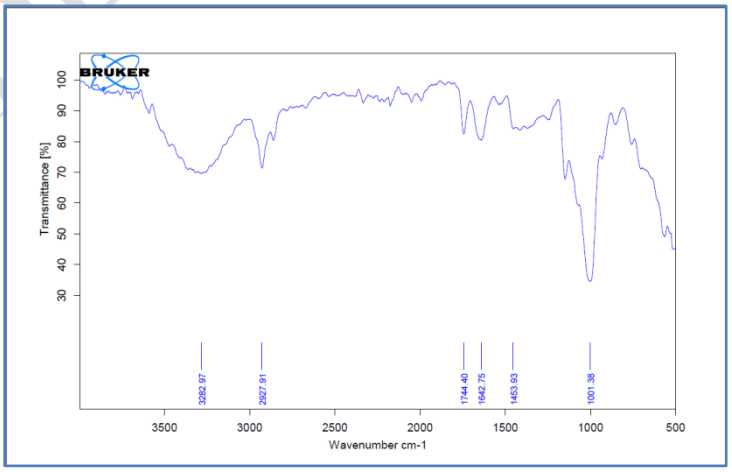

Figure 2: FT-IR analysis of khakhra

The data present in Fig-2 shows a peak at 2927.91 cm^{-1} which indicates the presence of CH stretching vibration. The peak of 1744.40 cm^{-1} indicates C=O stretching vibration. The band 1642.75 cm^{-1} represents N-H binding. Similar findings were reported by **[21]**.

Storage evaluation

The developed khakhra was packed in polyethylene and stored under refrigeration conditions (4°C) and ambient conditions (18-38°C). The powder was stored for 3 months (90 days) and was evaluated for its nutritional quality during storage.

Table 5: Storage studies of khakhra at ambient and refrigeration temperature

	Ambient temperature (18-38°C)				Refrigeration temperature (4°C)			
Parameters (%)	**0th day**	**1st month**	**2nd month**	**3rd month**	**0th day**	**1st month**	**2nd month**	**3rd month**
Moisture	8.2	8.33	8.39	8.42	8.2	8.23	8.26	8.27
Ash	1.5	1.47	1.45	1.38	1.5	1.49	1.47	1.46
Fat	13.86	13.83	13.79	13.70	13.86	13.84	13.82	13.78
Protein	10.83	10.81	10.74	10.71	10.83	10.81	10.79	10.78

The khakhra showed a significant increase in its moisture content from 8.2 per cent to 8.42 per cent. The ash content, fat and protein showed a decreasing trend from 1.5 per cent to 1.38 per cent, 13.86 per cent to 13.70 per cent and 10.83 per cent to 10.71 per cent respectively.

Moisture increased from 8.2 per cent to 8.27 per cent at refrigeration temperature. Furthermore, the fat, protein and ash content were reduced from 13.86 per cent to 13.78 per cent, 10.83 per cent to 10.78 per cent and 1.5 per cent to 1.46 per cent respectively. Less increase in moisture was noted for orange snacks prepared from freeze drying **[22]**.

The increase in moisture content may be due to the permeability of air. Protein and fat content might be decreased due to the denaturation of proteins and oxidation of lipids. The above values suggest that the increase in moisture was more for ambient temperature compared to refrigeration temperature. Moreover, the decrease in ash, protein and fat content was less at refrigeration temperature when compared with values of ambient temperature. The nutrients were better retained at refrigeration temperature with minimal changes. Thus, refrigeration temperature can be considered a better storage temperature.

Microbial evaluation

Initially, microbial growth was absent. However, as the storage period lengthened, slow microbial growth was observed. But the microbial count was within the safe limit. After 3 months, the total plate count (TPC) of khakhra obtained was 570cfu/g.

Cost of production

The prices of all ingredients were considered while calculating the expense incurred in the production of functional food products. The total price includes the processing fee as well as additional costs. The selling price was calculated after adding a 10 per cent profit margin.

Table 6: Cost of production of khakhra

Ingredients	Rate /100g	Quantity required (g)	Amount (₹)
Oats flour	26	90	23.40
Maize flour	12	10	1.20
Wheat flour	10	20	2.0
Pumpkin powder	6.6	10	0.6
Salt	2.5	1.2	0.03
Black pepper powder	148	0.5	0.74
Cumin powder	77	1.5	1.15
Carom seed powder	63	0.70	0.44
Refined oil	14.4	15	2.16
Miscellaneous charges	-	-	20
Processing charges	10 per cent profit of total charges	-	5.17
			Total Cost = ₹ 56.89

For the preparation of khakhra oats, maize and wheat flour were used. All the ingredients used fall under the minimal price range. The final total cost of khakhra obtained was ₹ 56.89 which is cheaper than commercially available khakhra.

CONCLUSION

Commercially available snacks are mostly loaded with fat with little or no nutritional value and are thus considered junk food. Regular consumption of these junk snacks may lead to serious health issues. The khakhra was made from oats, maize and wheat flour. The protein, fat, carbohydrates and fibre present in khakhra were 10.83 per cent, 13.86 per cent, 69.95 per cent and 5.34 per cent respectively. The khakhra was also rich in minerals like calcium, magnesium, iron and zinc. The FT-IR analysis showed various

peaks which confirmed the presence of bioactive compounds with the help of functional groups. On comparing the changes during storage at refrigeration and ambient temperature, it was found that minimum changes in the parameters were observed at refrigeration conditions. Hence the khakhra fortified with pumpkin powder could help individuals make a shift towards healthy snacks and can be recommended to individuals of all ages.

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