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Research Article

Quality assessment of value-added Indian recipe *pedakiya* prepared from composite flour and sesame seeds.

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Abstract
The present study was designed to enhance the nutritional value of the Indian recipe *pedakiya/gujiya*, a traditional sweet deep-fried dumpling, by utilizing the beneficial properties of composite flour (oat and peas flour) and sesame seeds. Furthermore, the study aimed to investigate the effects of partial substitution of refined wheat flour with oat and peas flour on nutritional, sensory, and microbiological parameters as affected by different cooking (deep-fat frying, baking, and air-frying) methods. The dough was developed by partially substituting a high percentage of refined wheat flour with oat flour, peas flour, and sesame seeds and based on the different treatments, these were coded as P_0 (control), P_1 (value-added *pedakiya* processed by deep-fat frying at 120 °C /5 minutes), P_2 (air-fried at 120 °C /30 minutes), and P_3 (baked at 200 °C /25 minutes). Based on sensory evaluation, sample P_1 was the most acceptable by the sensory panel. Chemical analyses revealed that the addition of composite flour and sesame seeds substantially increased the nutritional parameters of the product. The product's microbiological analyses revealed that, up to a 15-day storage period, the product was well within safe levels. Aluminum bags were determined to be a suitable packaging material for storing the value-added *pedakiya* based on the water activity (at 37 °C/91% RH) and overall acceptability scores. This study has provided an alternative approach for preparing traditional *pedakiya* by utilizing healthier options. The topic of the present study is very timely since consumers are constantly looking for better alternatives to traditional fried dishes.

Keywords: Chemical analysis, Microbiological stability, Oats flour, Peas flour, Sensory evaluation, Sesame seeds, Value-added *pedakiya*

INTRODUCTION

Snack foods are an essential diet component and have been widely commercialized over time. To fulfill the consumers' ever-changing tastes and expectations, and the elusive quest for something unique that also appeals to a wide range of people, formulating a snack food can be a great challenge today (Sharma *et al*., 2014). Increasing consumer awareness necessitates the production of high-protein, low-cost, and highly acceptable fried snacks (Senthil *et al*., 2002). Currently, composite flour production is an intriguing option that has gained widespread acceptance worldwide for the development of functional foods with essential nutritional value and health benefits (Getachew and Admassu, 2022). Composite flour is a blend of flour, starches, and other ingredients designed to partially or completely substitute wheat flour in bakery and pastry products. Composite flour offers a higher nutritional content in terms of minerals, vitamins, fibre, and protein than flour milled from a single cereal (Hasmadi *et al*., 2020). Some studies have suggested that composite flours made from cereal and leguminous plant proteins are excellent sources of protein that complement each other well in terms of their amino acid profiles, including essential amino acids (Igbabul *et al*., 2015; Nanyen *et al*., 2016). Throughout the world, composite flour has been extensively and widely used to prepare various types of value-added *sev*, bakery products like biscuits, cakes, cookies, bread, etc., and traditional products like *ladoo* (Omueti and Morton, 1996; Pandey and Sangwan, 2016; Pandey *et al*., 2018). The proportion of wheat flour necessary to achieve a specific impact in composite flour is determined by both the quantity and quality of wheat gluten used, as well as the type of product involved. As a result, when snack foods are prepared with composite flour, their quality should be as close as possible to that of goods made with wheat flour. Though wheat flour can be substituted at higher levels, the potential challenges involve a strong consumer preference for organoleptic properties provided by 100% refined wheat-based food products, a lack of adequate nutritional insight, change in the functional properties of the developed product, and millers' reluctance to use composite flour (Noorfarahzilah *et al*., 2014).

Pedakiya/gujiya is a traditional sweet deep-fried dumpling native to the Indian subcontinent made with wheat flour or refined wheat flour and stuffed with a mixture of sweetened khoa, roasted semolina, dried fruits, and grated coconut before being fried in ghee. It is also known as *gughara* in Gujarat, *karanji* in Maharashtra and Odisha, *somas* in Tamil Nadu, *garijalu* in Telangana, *kajjikayalu* in Andhra Pradesh, and *karjikay*i or *karigadubu* in Karnataka. *Pedakiyas* are highly popular in Bihar and the preparation involves the use of roasted semolina, nuts, and khoa as stuffing (https://www.bbc.com/travel/article/20230307). To enhance the nutritional parameters of the product, using composite flour, a blend of wheat and non-wheat flour can boost the nutritional value of food products by adding additional nutrients found in the non-wheat material. The combination of cereal-based products and legumes is critical for addressing the issue of protein-calorie malnutrition and increasing dietary protein intake (Tangariya *et al*., 2018).

The widespread application of oats in the food industry is attributable to their high protein content (12–20%), high digestibility (90–94%), and significant amount of dietary fiber (4–8% β-glucan). The high content of β-glucan is responsible for its beneficial role in many chronic diseases (Yang *et al*., 2023). Various other phytoconstituents are also present, including flavonoids, avenanthramides, flavonolignans, saponins, sterols, triterpenoids, and tocols. Oat has a variety of pharmacological properties, including antioxidants, anti-inflammatory attributes, wound healing, immune modulation, anti-diabetic, and anti-cholesterolaemic properties. Oats are considered a potential therapeutic agent based on all these biological activities. Furthermore, the lack of gluten is critical in celiac disease (Chauhan *et al*., 2018). Suzauddula *et al.* (2021) observed that incorporating oat flour into noodles significantly increased the nutritional parameters and sensory acceptance of the noodles (up to 30%).

Pea (*Pisum sativum*), is the second most important and nutrient-dense crop among legumes in terms of production. Peas are low-fat (3%), high protein (24%), carbohydrate (58%), and dietary fiber (12%) carrying food (Qayyum *et al*., 2017). Pea protein and flour display various useful functional properties, including solubility, emulsifying and foaming abilities, water-holding capacity, and gelling tendency (Ettoumi and Chibane, 2015). These functional properties are desired in a variety of foods to improve stability and shelf life. Qayyum *et al.* (2017) revealed that the substitution of wheat flour with pea flour at different levels for the development of biscuits resulted in a significant incline in the product's nutritional profile. The substitution of wheat flour for pea flour up to 20% had no detrimental effect on the consumer acceptability score.

Sesame (*Sesamum indicum L.*) is one of the world's oldest and most widely grown oilseeds (Melo *et al*., 2021). Due to the significant amounts of essential and non-essential amino acids present compared to other seed proteins, it is regarded as a significant protein source in terms of nutrition. It also contains a variety of nutrients that are necessary for maintaining good health. Sesame seeds have more protein (17–40%) than meat (18–25%) and cereals (7–13%). Incorporating sesame or its derivatives in snacks can help improve the health of suffering communities by providing excellent functional and nutritional properties to the products (Abbas *et al*., 2022). Sesamin, a major lignan found in sesame seeds, has antihypertensive, cholesterol-lowering, and anticancer properties. In hypertensive patients, sesame oil has been shown to inhibit human colon cancer growth in vitro, reduce lipid peroxidation, and increase antioxidant status (Elleuch *et al.,* 2011). Loza *et al*. (2017) developed cookies with improved functional properties using banana flour (20%) and sesame seeds (8%), and they were reported to have a higher antioxidant capacity with an IC 50 of 17.52 mg/mL and good storage stability.

Owing to the popularity of traditional snack foods in India, a crucial demand exists to improve the nutritional value of *pedakiya* by incorporating more nutrient-dense components other than conventional wheat flour. Therefore, the present study was undertaken to investigate the effects of partial substitution of refined wheat flour with oat flour, pea flour, and sesame seeds on nutritional, sensory, and microbiological parameters as affected by different cooking (deep-fat frying, baking, and air-frying) methods. Additionally, an effort was made to gauge the product's shelf life after storage in different packaging materials over time.

MATERIALS AND METHODS

Collection of materials

All the ingredients required to develop the Indian recipe *pedakiya* were purchased from the local market. Table 1 demonstrates the ingredient list used in the preparation of the *pedakiya*. Analytical grade chemicals and borosil glassware were used to assess quality.

Development of value-added *pedakiya*

The product was developed by partially substituting a high amount of refined wheat flour with oats flour (30%), pea flour (20%), and stuffing composed of sesame seeds (10%) and jaggery. For the development of the value-added *pedakiya*, the ingredients were mixed to form a dough. The dough was rolled out into puris and stuffed with a mixture of sesame seeds and jaggery. These were then tightened along the ends and subjected to three different processing treatments i.e deep frying until golden brown (120 °C for 5 minutes) air frying at 120 °C for 30 minutes, and baking at 200 °C for 25 minutes. Based on the processing treatments given, these were coded as P_0 (control), sample P_1 (deep-fried/120 °C for 5 minutes), sample P_2 (air-fried/120 °C for 30 minutes), and sample P_3 (baked/200 °C for 25 minutes). Fig. 1 depicts the flow diagram for the preparation of value-added *pedakiya*.

Physical characteristics

The weight loss after different processing treatments were calculated as the average of three individual samples (expressed in grams) using a digital weighing balance. A Vernier calliper was used to measure the diameter of the product, and an average mean of ten values was reported and expressed as a centimeter. Similarly, the height was recorded as an average mean of ten values and expressed as a centimeter.

Sensory analysis

The samples were coded for identification before being served to the panel for sensory assessment. A 10-member semi-trained sensory panellist made up of males and females from the Department of Food Technology, Bhaskaracharya College of Applied Sciences (BCAS), University of Delhi, evaluated the samples for appearance, color, texture, taste, flavor, and overall acceptability. A 9-point hedonic scale quality analysis was used to express the degree of acceptance, likeness, or preference, with 1 denoting extreme dislike and 9 denoting extreme likenesses. The samples (value-added *pedakiya* which were developed using different processing treatments) with the highest organoleptic parameters were then analyzed for chemical properties, microbial study, and shelf life.

Proximate analysis

Proximate analysis, including moisture, protein, lipids, and crude fiber, was analyzed as per AOAC (2010), and the amount of carbohydrates was determined using the difference method (Hossain *et al*., 2015).

Determination of moisture content

The moisture content in each sample was estimated using the AOAC (2010) method. Each sample (3 g) was dried for 3 hours in an oven at 105 °C to achieve constant weight, then cooled in a desiccator and the moisture content was measured. Each sample was examined in triplicate. The moisture content was calculated using the following formula:

$$\text{Moisture (\%)} = \frac{A-B}{A} \times 100 \qquad \text{Eq. 1}$$

Where:
A= weight (g) of the sample before drying, and
B = weight (g) of the sample after drying.

Determination of ash content

The total ash content of each sample was determined using a high-temperature muffle furnace capable of maintaining temperatures between 500 and 600 °C. Exactly 2 g of oven-dried sample was charred on a hot plate before being ignited for 5-6 hours at 550-600°C in a muffle furnace. Each sample was subjected to a triple analysis. The following formula was used to determine the ash content:

$$\text{Ash content (\%)} = \frac{\text{weight of ash}}{\text{weight of sample}} \times 100 \qquad \text{Eq. 2}$$

Determination of crude protein

The crude protein was calculated using the Kjeldahl nitrogen estimation method, according to AOAC (2010). Approximately 0.5-1 g of the sample was weighed into the digestion flask. The sample was treated with Kjeldahl catalyst and conc. H_2SO_4. One blank flask was prepared using all the above-mentioned chemicals except for the sample. The flasks were placed in a digester, and boiling was continued until the solution was clear. The contents were cooled before connecting the flask to the distillation unit. At the receiving station, a receiving flask containing standard boric acid and 2-3 drops of the mixed indicator was kept. Following the completion of the distillation process, the distillate was titrated with 0.2 N HCl to determine the nitrogen content of the sample. A conversion factor of 6.25 was used for the conversion of percent nitrogen into protein content of the sample:

$$\text{Protein content (\%)} = \frac{[(X-Y) \times N \times 1.4007 \times 6.25]}{W} \quad \text{Eq. 3}$$

Where:
X= volume (mL) of 0.2 N HCl used in blank titration;
Y= volume (mL) of 0.2 N HCl used in sample titration;
N= Normality of HCl;
W= weight (g) of sample;
14.007 = atomic weight of nitrogen, and
6.25 = the protein-nitrogen conversion factor.

Determination of fat content

A 5 g sample was added and transferred to an extraction thimble that had been dried overnight at 50 °C. The thimble was weighed and placed in the Soxhlet extractor, which had a reflux condenser and was connected to a boiling flask containing 250 mL of petroleum ether. A 150 drops/min heat rate was applied to the sample for approximately 14 hours. The vacuum condenser was utilized to evaporate the solvent. The solvent was allowed to completely evaporate in the flask by incubating it at 80–90 °C.

$$\text{Fat (\%)} = \frac{\text{Weight of fat}}{\text{Weight of sample}} \times 100 \quad \text{Eq. 4}$$

Determination of crude fiber

The sample (2 g) was accurately weighed into the fiber flask, and 100 ml of 0.255 N H_2SO_4 was added. The heating mantle was used to heat the mixture under reflux for 1 hour and then filtered through a fiber sieve cloth. The resulting filtrate was discarded, and the residue was returned to the fiber flask. To this, 100 ml of 0.313 N NaOH was added, and the mixture was heated under reflux for an additional hour. The contents were dried at 105 ± 2 °C in an air oven until a constant weight was achieved. The digested samples were placed in a muffle furnace and heated to 550-650 °C for 3-5 hours until grey or white ash formed. The percentage fiber was calculated using the given formula:

$$\text{Crude fiber (\% by wt.)} = \frac{A-B}{W} \times 100 \quad \text{Eq. 5}$$

Where:
A = Initial wt. (g) of crucible;
B = Final wt. (g) of crucible, and
W = Wt. (g) of the dried material taken for the test.

Microbial stability

The best-accepted sample from the sensory evaluation was tested for microbial stability in triplicate over 30 days (0-15-30) of room-temperature storage. Total plate count (TPC), yeast & mold, and Coliform tests were performed as per the procedure given by Thambekar *et al.* (2009).

Accelerated shelf life analysis

Accelerated shelf life studies in three different packaging materials using an environmental chamber were done for a storage period of 30 days (0th–7th–15th–30th). During this interval, the temperature-dependent water activity and moisture content were evaluated, and the overall acceptability scores were based on the suitability of packaging materials to keep the product safe and wholesome without any detrimental changes.

Statistical analysis

The analysis was done by applying average and variance techniques. The values were expressed as the mean ± standard deviation (SD) of three independent determinations.

RESULTS AND DISCUSSION

From all the variations, i.e., P_1 (deep-fat fried/120 °C for 5 minutes), P_2 (air-fried/120 °C for 30 minutes), and P_3 (baked/200 °C for 25 minutes), sample P_1 recorded the highest values for all sensorial attributes (aroma, color, taste, and texture) and thus had the highest overall acceptability. The control sample (P_0) and variation P_1 were the most widely accepted. As a result, the proxi-

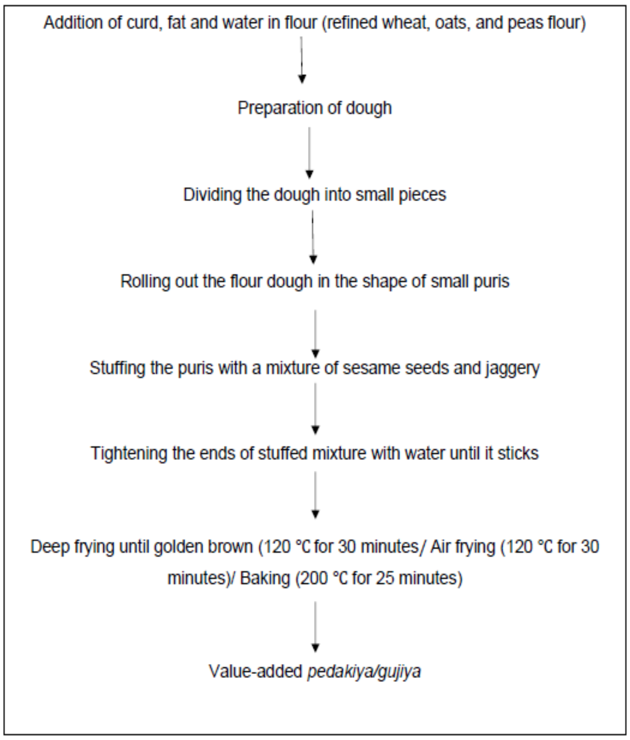

Fig. 1. *Flow chart of development of value-added pedakiya.*

Table 1. Ingredients for the development of value-added *pedakiyas.*

Ingredients for control formulation	Ingredients for sample formulation
Refined wheat flour (100%)	Refined wheat flour (40%)
Semolina	Oats flour (30%)
Dry Coconut powder	Peas flour (20%)
Sugar	Sesame seeds (10%)
Crushed cardamom seed	Jaggery
Ghee	Curd
Refined oil	Dry coconut powder
	Crushed cardamom seed
	Ghee
	Refined oil

mate and microbial analyses were performed on variation P_1.

Physical properties

The physical properties of developed *pedakiya* as affected by different frying treatments are shown in Table 2. There was no significant difference in diameter and height among all developed samples and the control. However, the processing treatment led to a substantial change in the weight of the product, with the deep-fat frying method favoring greater weight loss.

Sensory evaluation

The average and standard deviation of sensory scores against various parameters is shown in Table 3. The control sample, P_0 (100% wheat), scored the highest in all attributes, followed by sample P_1. Fig. 2 depicts the sensory analysis of the product and control sample regarding appearance, color, texture, flavor, and overall acceptability. Sample P_0 (7.8) had the highest mean score among the developed samples in terms of appearance, followed by samples P_1 (7.4), P_3 (7.2), and P_2 (7.0). With the change in heat processing treatments, the mean texture and flavor scores declined from 7.4 (P_1) to 6.9 (P_2) and 7.2 (P_1) to 6.5 (P_2), respectively. The mean score of the product in relation to taste indicated that sample P_0 (7.9) had the highest mean score followed by samples P_1 (7.3), P_3 (7.1), and P_2 (6.4). The quality characteristics of fried *pedakiyas* were not replicated by baking or air-frying, despite being a healthier alternative to frying. The air-fried samples (P_2) demonstrated a decrease in all sensory attributes, resulting in lower overall acceptance (7.2). Food was made significantly more appetizing when it was fried because hot frying fat that has seeped into it replaced some of the water it originally contained. This absorbed fat contributes to the popularity of deep-fried foods, namely their flavor, and crispiness, by exerting a tenderizing and wetting effect on the food and crust, respectively. The characteristic fried flavor is primarily caused by lipid degradation products derived from frying oils (Oke *et al*., 2017). Similar observations have been reported on the impact of baking and frying on the quality attributes of potato chips (Tuta and Palazolu, 2017) and commercial instant noodles (Wang *et al*., 2022).

Proximate composition analysis

The chemical compositions of the control and the best-formulated sample by sensory analysis are shown in Table 4. The proximate comparative analysis of samples P_1 (developed sample) and P_0 (control) is depicted in Figure 3. The substitution of refined wheat flour with oats and peas flour resulted in a higher content of protein in the developed sample (9.05%) than in the control (7.03%). The fiber (2.11%) and ash content (4.43%) increased in the sample (P_1) formulated with composite flour (oat and peas flour) and sesame

Table 2. Physical properties and water activity (a_w) of the control and developed value-added *pedakiyas.*

Samples	Weight loss after processing (g)	Height (cm)	Diameter (cm)	Water activity (a_w) at 25.25 °C
P_0	7.42± 0.08	4.82± 0.08	4.69± 0.01	0.4728± 0.04
P_1	7.92± 0.73	4.85± 0.09	4.62± 0.03	0.4724± 0.00
P_2	4.15± 0.69	4.95± 0.03	4.65± 0.05	0.3822± 0.08
P_3	7.02± 0.13	4.90± 0.04	4.50± 0.09	0.3653± 0.06

Values are expressed as the mean ± standard deviation (SD) of three independent determinations.
Where, P_0- control (100% refined wheat flour + semolina, sugar, coconut powder stuffing); sample P_1 = value-added *pedakiya* processed by deep-fat frying (deep-fried/120 °C for 5 minutes); P_2 = value-added *pedakiya* processed by air-frying (120 °C for 30 minutes); and, P_3 = value-added *pedakiya* processed by baking (200°C for 25 minutes).

Table 3. Average and standard deviation of sensory scores against different parameters.

Sensory attributes	Sample Code			
	P_0	P_1	P_2	P_3
Appearance	7.8 ± 0.26	7.4 ± 0.26	7.0 ± 0.79	7.2 ± 0.33
Color	7.4±0.26	7.1 ± 0.26	6.8 ± 0.82	6.8± 0.25
Texture	8.4 ± 0.20	7.4 ± 0.29	6.9 ± 0.76	7.1 ± 0.26
Taste	7.9 ± 0.21	7.3 ± 0.28	6.4 ± 0.81	7.1 ± 0.25
Flavor	7.8 ± 0.28	7.2 ± 0.28	6.5 ± 0.74	6.9 ± 0.23
Overall acceptability	8.4 ± 0.29	7.5 ± 0.67	7.2 ± 0.86	7.3 ± 0.41

Values are expressed as the mean ± standard deviation (SD) of three independent determinations.

Table 4. Proximate composition analysis of control and developed value-added *pedakiyas*

Parameters	Control (P_0)	Sample (P_1)
Moisture (%)	15.12 ± 0.32	16.28 ± 0.45
Ash (%)	2.12 ± 0.33	4.43 ± 0.24
Protein (%)	7.03 ± 0.08	9.05 ± 0.18
Crude fat (%)	17.12 ± 0.66	17.77 ± 0.45
Crude fiber (%)	1.24 ± 0.02	2.11 ± 0.62
Total carbohydrates	57.37 ± 0.85	50.36 ± 0.77

Values are expressed as the mean ± standard deviation (SD) of three independent determinations.
Where, P_0- control (100% refined wheat flour + semolina, sugar, coconut powder stuffing); sample P_1 = value-added *pedakiya* processed by deep-fat frying (deep-fried/120 °C for 5 minutes).

seeds, which are considered to be rich sources of dietary fiber and minerals (Elleuch *et al*., 2007). On the other hand, the moisture content in the sample (P_1) was found to be comparatively on the higher side. The addition of sesame seeds was linked to the product's crude fat content as the main contributor. High temperature and oil mass transfer during frying can change the composition, structure, and physicochemical characteristics of the various food ingredients (Wang *et al*., 2022). These are often followed by unfavorable changes, one of which is the loss of nutrients, particularly vitamins, during frying (Oke *et al*., 2017). However, no such adverse impact on the nutritional parameters was observed in the present study, which can be attributed to the addition of nutritionally rich base ingredients.

Microbiological stability

Table 5 demonstrates the microbial quality on the 0th, 15th, and 30th days. The microbial analysis is used to determine the product's shelf life. The developed sample and control products were tested over 30 days. The increase in microbial load as the storage period lengthened could be attributed to an increase in moisture content during the storage, but the bacterial and fungi count remained well within the acceptable limits (up to 15 days). The rate of many chemical reactions in foods, as well as the rate of microbial growth, is greatly influenced by water activity. After 15 days of storage at room temperature, the yeast and mold count in sample P_1 was 4.4 x 10 CFU/g, while after 30 days of storage, the count was 2.00 $\times 10^3$ CFU/g, exceeding the maximum permissible limits of FDA specifications (<50 CFU/g). According to Păucean *et al*. (2015), molds and yeasts will begin to grow at water activities (a_w) of 0.7 to 0.8. Bacterial growth will occur when the water activity level reaches 0.8. The microbial analysis demonstrated that the product (value-added *pedakiya*) has a shelf life of fifteen days, after which the growth of microbes was found to be predominantly high, which might have deteriorated the organoleptic characteristics and microbial safety of the food. The samples were found to be negative for the coliform count.

Accelerated shelf life studies

The data pertaining to the water activity and overall acceptability of value-added *pedakiya* at different time intervals after storing in different packaging materials is given in Table 6. The water activity (a_w) measurement provides critical information about the quality of a product. The control over moisture content and water activity helps in controlling the growth of microorganisms, thereby improving the product's shelf stability. Molds, yeasts, and bacteria use free water to grow and produce toxins, which might degrade a product's texture, flavor, color, taste, nutritional value, and shelf-life stability (Sandulachi, 2012). The water activity (a_w) of products stored in polythene, aluminium, and transparent polyvinyl chloride (PVC) bag ranged from 0.4724-0.6624, 0.4724-0.5621, and 0.4724-0.6494, respectively (Fig. 4). As evident from Table 6, the aluminium bag provided good barrier properties against moisture content (16.28 to 22.41%) over the storage period from 0

Table 5. Microbial analysis on the 0th, 15th, & 30th day at 28 °C.

Parameters	**Storage day (s)**	**Control sample (P_0) (CFU/g)**	**Sample (P_1) (CFU/g)**
Yeast and mold growth	0th	Nil	Nil
	15th	5.4 x 10	4.4 x 10
	30th	2.2 x 10^3	2.00 x 10^3
Total Plate count (TPC)	0th	Nil	Nil
	15th	3.00 x 10^3	2.20 x 10^3
	30th	4.11 x 10^5	3.46 x 10^5
Coliform count	0th	Absent	Absent
	15th	Absent	Absent
	30th	Absent	Absent

Where, P_0- control (100% refined wheat flour); sample P_1 = value-added *pedakiya* processed by deep–fat frying (deep-fried/120 °C for 5 minutes); CFU = Colony Forming Unit.

Table 6. Accelerated shelf life studies and overall acceptability of value-added *pedakiyas* during storage in different packaging materials

	Water activity (a_w) [Environmental chamber - 37 °C/91% RH]			
Samples	**0th day**	**7th day**	**15th day**	**30th day**
Polythene bag	0.4724 ± 0.00	0.5444 ± 0.04	0.5926 ± 0.04	0.6624 ± 0.02
Aluminium bag	0.4724 ± 0.01	0.5021 ± 0.03	0.5321 ± 0.02	0.5621 ± 0.03
Transparent PVC bag	0.4724± 0.00	0.5274 ± 0.01	0.5769 ± 0.04	0.6494 ± 0.02
Moisture content (%)				
Polythene bag	16.28 ± 0.45	19.29 ± 0.03	22.25 ± 0.28	25.27 ± 0.36
Aluminium bag	16.28 ± 0.36	18.35 ± 0.09	20.23 ± 0.20	22.41 ± 0.42
Transparent PVC bag	16.28 ± 0.33	19.02 ± 0.02	22.04 ± 0.26	25.26 ± 0.36
Overall acceptability				
Polythene bag	7.5 ± 0.01	5.9 ± 0.01	5.2 ± 0.26	3.1 ± 0.36
Aluminium bag	7.5 ± 0.01	6.7 ± 0.03	5.5 ± 0.29	5.3 ± 0.34
Transparent PVC bag	7.5 ± 0.00	5.9 ± 0.01	5.5 ± 0.32	3.7 ± 0.40

Values are expressed as the mean ± standard deviation (SD) of three independent determinations.RH = Relative humidity.

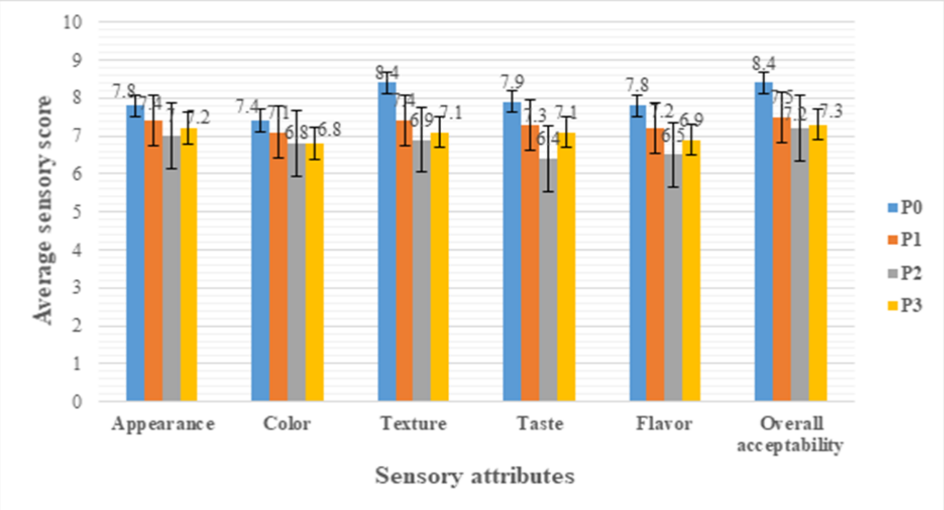

Fig. 2. *Average sensory score of different parameters in control and developed sample (value-added pedakiya); P_0- control (100% refined wheat flour + semolina, sugar, coconut powder stuffing); sample P_1 = Value-added pedakiya processed by deep-fat frying (120 °C for 5 minutes); P_2 = Value-added pedakiya processed by air-frying (120 °C for 30 minutes); and, P_3 = Value-added pedakiya processed by baking (200 °C for 25 minutes).*

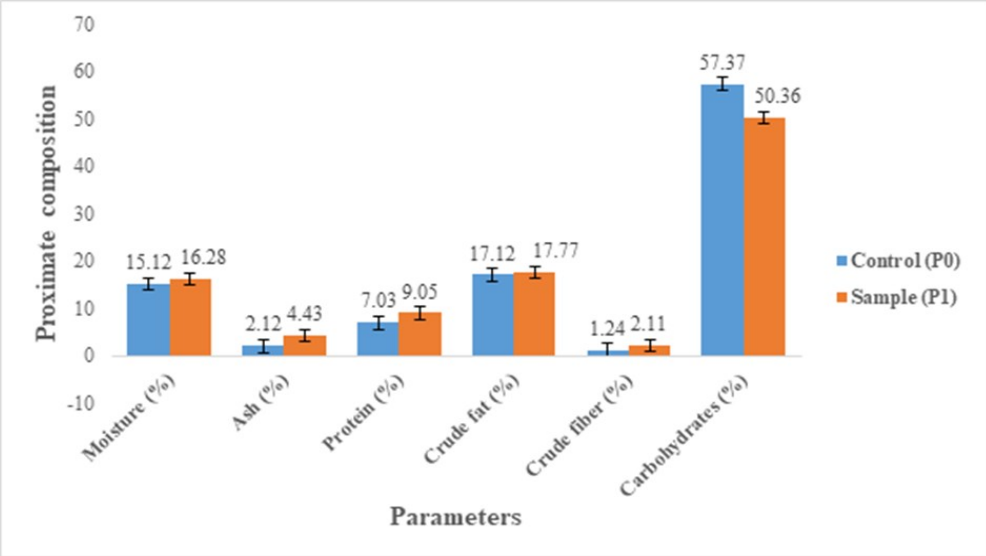

Fig. 3. *Proximate composition of developed value-added pedakiya;*
P_0- control (100% refined wheat flour + semolina, sugar, coconut powder stuffing); sample P_1 = value-added pedakiya processed by deep-fat frying (120 °C for 5 minutes); P_2 = value-added pedakiya processed by air-frying (120 °C for 30 minutes); and, P_3 = value-added pedakiya processed by baking (200 °C for 25 minutes).

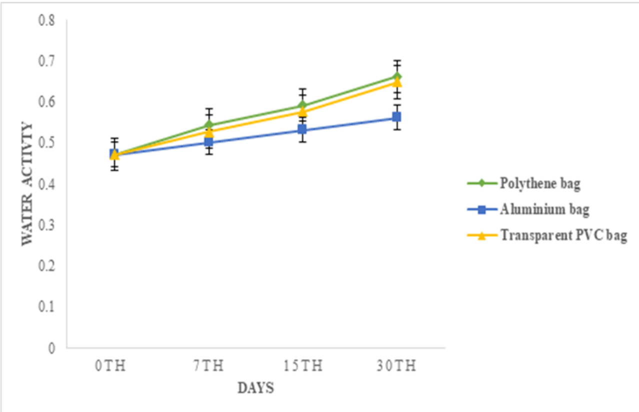

Fig. 4. *Variation of water activity (a_w) of value-added pedakiya during storage in different packaging materials*

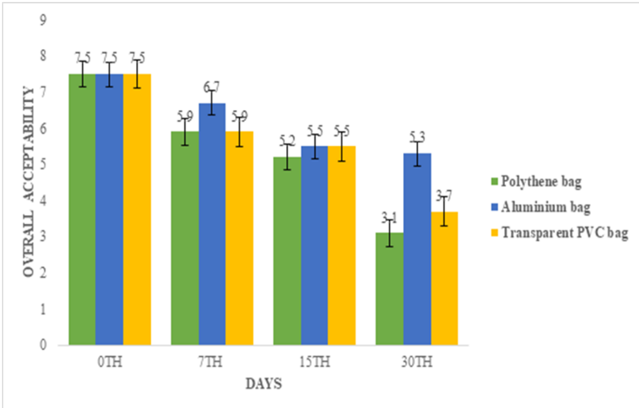

Fig. 5. *Overall acceptability of developed value-added pedakiya during storage in different packaging materials.*

to 30 days and therefore, scored well in terms of overall acceptance (Fig. 5). The lowest overall acceptance was recorded for samples stored in polythene bags (3.1 on the 30th day), which could be attributed to the poor barrier mechanisms against parameters such as air, temperature, moisture, and chemical.

When food is fried, the hot frying oil that has seeped into it partially replaces the water it contained, making the food much more appetizing. This absorbed fat contributes to the demand for deep-fried foods, specifically their flavor, crispness, and the pleasure of eating, by exerting a tenderizing and wetting influence on the food and crust, respectively (Oke *et al.*, 2017). Although baking and air frying are superior methods to the conventional deep-frying method of producing snack foods, the low rate of heat transfer associated with baking caused slow cooking and consequently longer processing times, which failed to deliver the quality attributes desired by consumers. Much effort is required to optimize the composite flour used for the development of such traditional snack food recipes by combining different types of crop flours to maximize the composite cooking quality utilizing the mixture response surface methodology. Further research may include an in-depth examination of the nutritional constituents and functional properties of composite flour used for the preparation of value-added *pedakiya*. Moreover, the study could be exploited to investigate the impact of different processing treatments such as deep-fat frying, air-frying, and baking, on the rheological and textural properties associated with such traditional snack foods.

Conclusion

Composite (oats and pea flour) flour could be used in the formulation of traditional snack foods in place of wheat flour, enhancing the product's nutritional value and fiber content. In this study, wheat flour was substituted with oat (30%) and pea flour (20%) for the preparation of value-added *pedakiyas*, with a stuffing of sesame seeds and jaggery. The developed product was examined for its proximate composition, sensory attributes, and shelf life as affected by different frying conditions, viz., deep-fat frying, baking, and air-frying. Also, the product was assessed for its shelf life when stored in different packaging materials over a storage period of 30 days. Based on the present findings, it was determined that P_1 (40:30:20 ratio of refined wheat, oats, and peas four; deep-fat fried) was the most acceptable in terms of all sensory attributes such as color and appearance, taste, flavor, texture, and overall acceptability, with nutritional values of carbohydrates, protein, ash, fat and crude fiber as 50.36, 9.05, 4.43, 17.77, and 2.11% respectively. The product's microbiological analyses revealed that the contamination levels were within safe limits during storage. Aluminium bags were discovered to be suitable for storing the product. This study has provided an alternative method for preparing value-added *pedakiya* by utilizing more healthy alternatives, as the traditional method only involves deep-frying treatments, but acceptable quality attributes were not achieved. Also, the study could be expanded further to examine the texture profiles of such developed products after being subjected to different processing treatments.

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Conflict of interest
The authors declare that they have no conflict of interest.

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