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Formulation of healthy cookies incorporated with orange peel powder and *Moringa oleifera* leaf powder

Nikita Vilas Teke, Karuna Wasudeo Patil, Hemangi Jayram Gavit *

Rayat Shikshan Sanstha's Annasaheb Awate College, Manchar, Pune 410503, India

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ABSTRACT

Studies were conducted for the incorporation of OPP (Orange peel powder) and MLP (Moringa leaves powder) in cookies. The OPP and MLP were analyzed and used in whole WF 100gm (0.5 gm, 1 gm, 1.5 gm, 2 gm, 2.5 gm, 3 gm, 3.5 gm, 4 gm) and MLP (0.5 gm, 1 gm, 1.5 gm 2 gm, 2.5 gm, 3 gm, 3.5 gm, 4 gm) proportion respectively. Based on sensory evaluation, 3% of OPP and 1% of MLP were selected for the preparation of healthy cookies. In the present work, OPP and MLP were prepared by using the tray dryer method. Jaggery and whole wheat flour were used instead of sugar and maida. The final formulation of the cookie mixture containing wheat flour (WF), OPP, and MLP was in the 96:3:1 ratio and resulted in the highest sensory score. The cookies were analyzed for various nutrients and phytochemical compounds. The utilization of waste orange peel and Moringa leaves was the most significant aspect of this study.

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1. Introduction

Health-promoting foods including cookies have recently been in focus and of great interest to consumers, dieticians, experts, and producers. Cookies were classified as one of the most highly distributed bakery products in the market worldwide, because it is ready to eat, cheap, nutritionally rich, available in different tastes and have a longer shelf life [1].

The nutritional composition of Moringa of the South African ecotype has also been reported that including the profiling of chemical composition, fatty acids, amino acids, and vitamins. Amino acids, fatty acids, minerals, and vitamins are essential in animal feed. These nutrients are used for osmotic adjustment; activate enzymes, hormones, and other organic molecules that enhance growth, function and maintenance of life process [2].

Studies have also revealed that the leaves have immense nutritional value to combat malnutrition, especially among infants and nursing mothers. In addition, nutrition plays a crucial role in both humans and livestock as short-term alternative to chemoprophylaxis. In animals, nutrition plays a major role in animal's ability to overcome the detrimental effects of parasitism and diseases [3].

It is important to emphasize that orange peel, a byproduct of citrus manufacturing that is typically discarded, is actually valued as a functional food. Citrus peels may therefore boost health in a ddition to the usual nutrients they contain and help ward off disorders linked to food, such as osteoporosis, metabolic syndrome, type II diabetes, coronary heart disease, obesity, and hypertension [4].

The nutritional benefits of Moringa vary widely and are influenced by things like genetic makeup, environmental conditions, and production practices [5]. As a potential inhibitor of some microorganisms, such as bacteria (*Escherichia coli, Staphylococcus aureus, Vibrio parahaemolyticus, Enterococcus faecalis, Pseudomonas aeruginosa, Salmonella enteritidis, and Aeromonas caviae*) and fungi (*Trichophyton rubrum, Trichophyton mentagrophytes, Epidermophyton floccosum and Microsporum canis*), moringa leaf extracts were also able to act as a biocidal agent [6].

In addition to energy, proteins, minerals (zinc, copper, and iron), and vitamins (A and E) are all necessary for an animal to develop immunity (for the production of antibodies and cells) [7]. These nutrients also help organs and tissues communicate with one another to fight infections. Due to its several uses, moringa oleifera is regarded as a plant of versatility. Its leaves are an excellent source of calcium, iron, and vitamins A, B, and C [8].

* Corresponding author.
E-mail address: nikitateke03@gmail.com (N.V. Teke).

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The majority of the world's population enjoys eating baked items made only with wheat flour. In nations like Nigeria, these goods have continually been consumed [9]. A well-fed animal is more resistant to disease than one that is already weak from starvation, even when exposed to infection. An animal's immune system responds to pathogen exposure by mounting an attack to ward off infection. This includes raising antibodies to fight the infection, as well as using white blood cells to attack pathogens [10]. In Africa, nursing mothers have been shown to produce much more milk when they add Moringa leaves to their diet. Severely malnourished children were reported to have made significant weight gains when caregivers add the leaves to their diet to increase their nutritional content [11].

Citrus by-products, if utilized fully, could be major sources of phenolic compounds. The peels, in particular, are an abundant source of natural flavonoids and contain a higher amount of phenolics compared to the edible portions [12].

The healing of abdominal tumors, hysteria, scurvy, paralytic attacks, helmintic bladder, prostate issues, ulcers, skin infections, inflammation, cardiovascular, and liver illnesses are just a few of the health issues and diseases that moringa is helpful for. Moringa, also protects body from arsenic-induced oxidative stress and in the depletion of arsenic concentration. Moringa is considered as a hypocholesterolemic agent, regulation of thyroid hormone status, anti-diabetic agent, antipyretic, antiepileptic gastric ulcers, antitumor agent, and hypotensive agent [13–15]. It is considered as one of the World's most useful trees, as almost every part of the Moringa tree can be used for food, medication and industrial purposes [16].

The wastes of fruits and vegetables are inexpensive, abundantly available, and are a good source of.dietary fiber [17]. The orange peel is thought to contain some essential nutrients and has certain qualities that help the gastrointestinal tract operate properly. It is also great for diabetics and heart patients. Besides the nutritional aspect, it is having an affordable aspect as well. A segment membrane of citrus fruits appears to be able to prevent prostate and other cancers by acting as a mediator in cell communication, a factor known to reduce the likelihood of abnormal cell growth. Sour fruits such as lemon appear to have the greatest effect [18]. Moringa leaves are more potent in nutritional value. Its vitamin C content is seven times more than that of oranges, it has thirteen times more vitamin than spinach, and is on a lead on its own when it comes to the amino acid, 2,000 times more than green tea and 242 times more than apples. The leaves are sources of sulfur-containing amino acid such as methionine and cystine which are often in short supply in most legumes [19].

Bakery products have become more popular in India since earlier times. Among the different bakery products cookies constitutes the most popular group. Cookies were created fairly early. Because of their extremely low moisture content, they can be preserved for a long period. Cookies are chemically leavened bakery items with a high fat and sugar content [20].

Wheat as a major source of raw material for the production of these baked products such as cookies also lacks some nutrients. *Moringa oleifera* is an important food commodity that has had enormous attention as the 'natural nutrition of the tropics. The leaves, seeds, and flowers of *Moringa oleifera* all have great nutritional and therapeutic value [21].

The seeds are eaten like peas or roasted like nuts when still green; the dry seeds are apparently not used for human consumption, perhaps because the bitter coating becomes hardened while the flowers are eaten when cooked and taste like mushrooms [22]. The leaves are outstanding as a source of vitamins A, B group and (C when raw) and are among the best sources of minerals. They are also excellent sources of protein, but poor sources of carbohydrate and fat. Moringa leaves are one of the best plant foods available in nature.

The leaves of Moringa was considered as a very nutritional material as it contains vitamin A, vitamin C, iron, calcium and potassium in concentrations as much as in carrot, orange, spinach and banana. It is also a good protein source based on a comparison between its amino acid profiles and FAO/WHO/UNO reference protein for children. Its content of protein are more than that found in egg and soybean and contains a wide range of amino acids including zeatin, glutamic, arginine, and aspartic acid. Also, it contains carotenoid pigments, flavonoids, minerals, sterols and some phenolic compounds. Moringa leaves was proved to possess a high antioxidant activity values which played a potential rule in cancer chemoprevention, protein oxidation reduction and lipid peroxidation inhibition [23].

Since ancient times, 70 percent of the total production of oranges is used for the manufacture of derivative products, but 30 percent of processed fruits are converted into citrus peels waste, so these wastes contain many nutrients. Fruit peels serve as a barrier, shielding the edible components of the fruit from external elements as well as microorganisms and enzymes. They may or may not be considered fruits depending on their thickness and flavor. People frequently discard the peels of fruits after eating them, although the peels contain many of the fruit's nutritional benefits. They help protect our bodies from many diseases and increase disease resistance. Apart from this, various types of dishes, cosmetics, and medicines are also prepared by using these nutritious peels properly [24].

According to the World Health Organization (2003) report, "Dietary nutrition and prevention of chronic disease", it prevents heart disease due to folate present in citrus fruits, which is essential to lower levels of the heart. Potassium helps lower blood pressure, prevents stroke and kidney disease, and vitamins, carotenoids, and flavonoids are found in citrus fruits, all of them as protective cardiovascular effects.

2. Methodology

Refined wheat flour, jaggery, hydrogenated vegetable oil, baking powder, baking soda, salt, and milk were obtained from the local market of Manchar. Essence was obtained from the natural orange peel powder, moringa leaves powder to prepare at a college level by using the tray dryer method. All chemicals and reagents used were of analytical grade.

2.1. Preparation of orange peel powder

First, The orange fruits were washed under running water, disinfected and rinsed. The orange peels were manually removed using stainless steel knives and weighed to determine the yield. Material preparation and physicochemical analyses were performed at the laboratory. After the peels were weighed, they were cut into small pieces then dried in a tray dryer at 40 °C for 24 h and ground, then sieved through a 50 mesh sieve to obtain a powder. The peel powder was again weighed to calculate the yield, then orange peel powder was vacuum packed and stored at room temp for future analysis.

2.2. Preparation of Moringa leaves powder

First, the fresh moringa leaves were separated from the stalks of the ties,it was then removed from the leaf petal by hand. The leaves were placed on a tray dryer45 °C for 24 h. After drying, dried moringa leaves were ground in the grinder to reduce the particle size. The ground material is then allowed to pass through a sieve

size 50 mesh, the larger particle on the sieve was again taken for grinding and passed through the sieve to obtain a fine powder. The moringa leaves powder was vacuum-packed and stored at room temperature for future analysis.

2.3. Preparation of cookies

Cookies were prepared by using the standardized recipe and method given by (Table 1):

According to the recipe, blends were made by combining milk, wheat flour, moringa leaf powder, and orange peel powder in various dry-weight ratios. These mixtures were standardized to produce products with acceptable physical characteristics and greater nutritional value. The dry ingredients i.e. wheat flour, MLP(moringa leaves powder), OOP(orange peel powder), baking powder, baking soda, salt, and flavour (cardamom and nutmeg powder) were mixed. A homogenous paste of fat and jaggery was prepared by hand to obtain a uniformly mixed dough. The prepared dough was rolled in a uniform shape and cut into round shape cookies with the help of a cutter. These cookies were baked at 160 °C top and 150 °C bottom for 25 min. Preparation of cookies was carried out using wheat flour samples replaced separately with (0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4) OOP and MLP (0.5, 1, 1.5, 2, 2.5, 3, 3.5, 4) The method of cookies is a flow sheet in Fig. 1.

2.3.1. Optimization of Moringa powder in final cookies

Moringa powder optimization in the final cookies is shown in Table 2. Wheat flour, fat, baking powder, baking soda, salt, milk, and jaggery were all used in constant amount as mentioned in the Table 2. While the amount of Moringa leaf powder was changed in respective sample, to achieve an acceptable level of quality for optimization. The range of the MLP was 0.5gm to 4.0gm. Further, the sensory assessment of the product was carried out using 9 point Hedonic scale depending on which the suitable sample was selected. Sample T2 was chosen based on the sensory assessment.

2.3.2. Optimization of orange peel powder in final cookies

Orange peel powder optimization in the finished cookies is shown in Table 3. Wheat flour, fat, baking powder, baking soda, salt, milk, jaggery, and moringa powder were all kept constant in the final cookies while orange peel powder was changed to achieve an acceptable level of quality. The range of the OPP was 0.5gm to 4.0gm. Further, the sensory assessment of the product was carried out using 9 point Hedonic scale depending on which the suitable sample was selected. Sample T6 was chosen based on the sensory assessment.

Table 1
Ingredients used for preparation of cookies.

Sr. no	Ingredient Quantity
1	Wheat flour
2	Jaggery
3	Fat
4	Salt
5	Baking powder
6	Baking soda
7	Milk

2.4. Analysis of orange peel powder and Moringa leaves powder cookies

2.4.1. Physical analysis

Orange peel powder and moringa leaves powder cookies were analyzed for weight, Diameter, thickness, spread ratio, by following the respective procedures (AACC, 2000) [25].

Diameter (D): Six cookies were placed horizontally (edge to edge) and rotated at 90°angle for reading. Measured by vernier caliper.

Thickness (T): biscuits thickness was measured with a vernier caliper in triplicate. Means were recorded. Six cookies were measured one-by-one.

Spread ratio (SF): It was calculated according to the following equation.

$$SF = D/T$$

2.4.2. Chemical analysis

Moisture: Estimation of moisture content by hot air oven method at 105 °C for 4 hrs (AOAC, 1995) [26].

Ash: By using muffle furnace method up to constant weigh. Ignite in a muffle furnace at 550+/ - 250c for 4 hrs. [27].

Fat: Extracting the sample in a Soxhlet apparatus for 6-8h using petroleum ether. The solvent is evaporated and the residue is weighed [27].

2.4.3. Sensory analysis

Sensory evaluation: Evaluate the products for acceptability based on its flavour, texture, appearance, amount of bitterness and overall acceptability using nine-point hedonic scale.

(1 = dislike extremely to 9 = like extremely; Meilgaard et al., 1999).

Shelf life analysis: The Orange peel powder and moringa leaves powder cookies samples were packed in LDPE packaging material under ambient temperature for 45 days has evaluated.

3. Result and discussion

3.1. Optimization

The optimization of control cookies was carried out by varying proportion of different components such as flour, jaggery, salt, milk and fat. In the 1st trial Wheat flour content was varied to get an acceptable quality of cookies. The preparation of control cookies the amount of wheat flour was varied as 90 %, 95 % and 100 %. sample 100 % was finalized due to its good characteristics (Fig. 2).

In 2nd trial the control cookies were prepared by using wheat flour, jaggery, baking powder, baking soda milk. In this case of fat were optimized i.e. 50, 70, and 90 gm respectively. Depending upon sensory evaluation cookies having good taste, texture and overall acceptability 70 gm were finalized.

In 3rd trial the control cookies were prepared by using wheat flour, fat, baking powder, baking soda milk. In this case of jaggery were optimized i.e. 25, 50, 75 gm respectively. Depending upon sensory evaluation cookies having good taste, texture and overall acceptability 50 gm were finalized.

In 4th trial, the control cookies were prepared by using wheat flour, fat, baking powder, baking soda, and jaggery. In this case of milk was optimized. i.e. 30, 45, 60 ml respectively. Depending upon sensory evaluation cookies having good taste, texture, and overall acceptability 45 ml were finalized.

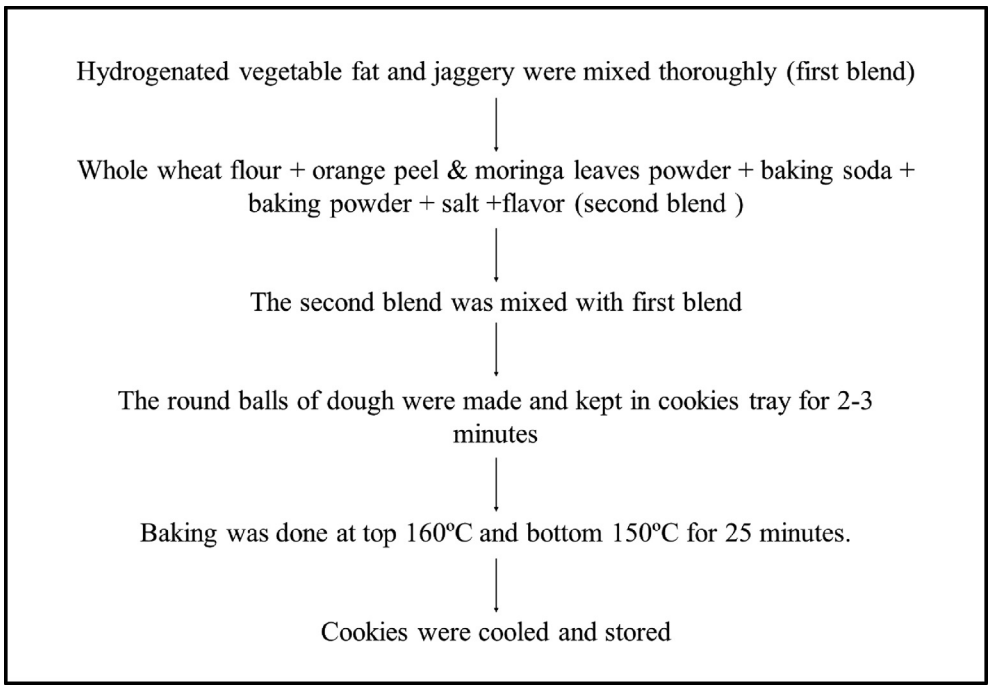

Fig. 1. Flow sheet for preparation of cookies.

Table 2
Optimization process of Moringa powder.

Sample code	Wheat flour (gm)	Fat (gm)	Baking powder (gm)	Baking soda (gm)	Salt (gm)	Milk (ml)	Jaggery (gm)	Moringa powder (gm)
T1	100	70	2	2	0.5	45	50	0.5
T2	100	70	2	2	0.5	45	50	1
T3	100	70	2	2	0.5	45	50	1.5
T4	100	70	2	2	0.5	45	50	2
T5	100	70	2	2	0.5	45	50	2.5
T6	100	70	2	2	0.5	45	50	3
T7	100	70	2	2	0.5	45	50	3.5
T8	100	70	2	2	0.5	45	50	4

Table 3
Optimization of orange peel powder.

Sample code	Wheat flour (gm)	Fat (gm)	Baking powder (gm)	Baking soda (gm)	Salt (gm)	Milk (ml)	Jaggery (gm)	Moringa powder (gm)	Orange peel powder (gm)
T1	100	70	2	2	0.5	45	50	1	0.5
T2	100	70	2	2	0.5	45	50	1	1
T3	100	70	2	2	0.5	45	50	1	1.5
T4	100	70	2	2	0.5	45	50	1	2
T5	100	70	2	2	0.5	45	50	1	2.5
T6	100	70	2	2	0.5	45	50	1	3
T7	100	70	2	2	0.5	45	50	1	3.5
T8	100	70	2	2	0.5	45	50	1	4

In 5th trial, all ingredients were kept constant only varied salt content based on taste parameters i.e. 0.3, 0.5, 0.7gm respectively. Depending upon sensory evaluation cookies having good taste, texture, and overall acceptability of 0.5 gm were finalized.

In the 6th trial, whole wheat flour 100gm with *Moringa oleifera* leaves powder 0.5gm, 1gm, 1.5gm, 2gm, 2.5gm, 3gm, 3.5 gm, 4gm based on taste parameters. Depending upon sensory evaluation cookies having good taste, texture, and overall acceptability of 1 gm were finalized.

In 7th trial whole wheat flour 100gm with orange peel powder 0.5gm, 1gm, 1.5gm, 2gm, 2.5gm, 3gm, 3.5 gm, 4gm based on taste parameter. Depending upon sensory evaluation cookies having good taste, texture, and overall acceptability 3 gm were finalized.

In 8th trial, all ingredients were kept constant only varied time and temperature. i.e. top and bottom temp (180–160 for 15 min, 160–160 for 18 min, 160–150 °C for 25 min).

After the trails, the final cookies were prepared using ingredients as per mentioned in Table 4. These cookies were used for sensory evaluation.

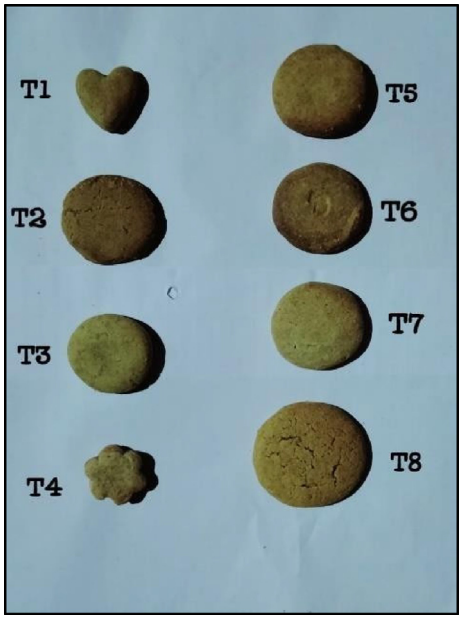

Fig. 2. Image of cookies trial (trial 1 to 8).

Table 4
Standardized recipe for cookies.

Sr. no	Ingredient Quantity	Quantity
1	Wheat flour	100 gm
2	Jaggery	50 gm
3	Fat	70 gm
4	Salt	0.5 gm
5	Baking powder	2.0 gm
6	Baking soda	2.0 gm
7	Milk	45 ml

3.2. Sensory evaluation of cookies

The effect of MLP fortification on sensory characteristics (color, taste, flavour, texture and overall acceptability) of wheat flour cookies is shown in Table 5 and Table 6. The color, taste, flavour and texture of control sample and cookies fortified with 1 % MLP and 3 % OPP extract were significantly superior to MLP and OPP cookies. Cookies fortified with 1 % MLP and 3 % OPP extract had the highest scores of flavour, texture and overall acceptability being (8.5, 8.3, 8.4) and (8.3, 8.5, 8.5) respectively. Cookies fortified with above 1 % MLP and 3 % were not acceptable. The results of sensory evaluation indicated that 1 % MLP and 3 % OPP extract can be successfully used in wheat flour cookies.

3.3. Physical parameters of cookies

Various physical parameters such as thickness, diameter, weight and spread ratio were studied before and after baking and are shown in Table 7. The cookies observed are shown in Fig. 3 and Fig. 4.

3.4. Shelf life of orange peel powder and moringa leaves powder cookies

Shelf life of orange peel powder and moringa leaves powder cookies was carried out from 0 days to 45 days packed in LDPE pouches at ambient temperature (Fig. 5).

4. Conclusion

The present investigation focused on utilization of orange peel powder and moringa leaves powder for formulation of healthy cookies. The development and consumption of such products can also aid in improving the nutritional status of developing children. Orange peel powder and moringa leave powder are waste products derived from orange and moringa oleifera and possess good nutritional value, functional properties, dietary fiber, antioxidant, and antimicrobial properties. The MLP and OPP were optimized and the best sample was selected on the basis of sensory evaluation using nine-point Hedonic scale. Different optimization techniques were tested, and among those formulations, the product made with moringa powder was chosen for a 1 % sample based on sensory analysis, and the product made with orange peel powder for a 3 % sample.

Seven trials were conducted to formulate the ingredients in final cookies which included wheat flour, fat, jaggery, milk, salt, MLP and OPP. In the last eight trial, time and temperature were optimized. The final cookies were prepared according to the optimized ingredients and parameters. Further, the final product was sujected to the sensory evaluation. The cookies were evaluated depending on the color, texture and taste.

The results of Moringa's nutrient characterization provide strong evidence that the plant's leaves are nutrient-rich. Orange peel is thought to include several essential nutrients and possesses particular qualities that help the gastrointestinal tract work properly and is great for diabetics and heart patients. This study suggest that the moringa leaves and orange peels can be incorporated in the diet through the bakery products and be used as a nutritional supplement. The products can further be analyzed for its nutritional components.

Table 5
Sensory evaluation of moringa leaves powder in cookies.

Sample Ccode	Sensory attributes				
	Color and appearance	Texture	Flavour	Taste	Overall acceptability
Control	8.5	8.5	8.5	8.5	8.5
MLP (0.5)	8.0	8.0	8.5	8.0	8.0
MLP (1.0)	8.5	8.3	8.3	8.4	8.3
MLP (1.5)	8.0	8.5	8.0	8.3	8.3
MLP (2.0)	8.0	8.5	8.5	7.0	7.0
MLP (2.5)	7.5	8.5	7.5	7.5	7.5
MLP (3.0)	7.5	8.5	6.0	6.5	6.5
MLP (3.5)	6.5	8.5	5.5	6.0	6.0
MLP (4.0)	6.5	8.5	5.0	5.5	5.5
Mean	**7.66**	**8.42**	**7.31**	**7.3**	**7.28**

MLP =Moringa leaves powder.

Table 6
Sensory evaluation of orange peel powder in cookies.

Sample code	Sensory attributes				
	Color & appearance	Texture	Flavour	Taste	Overall acceptability
Control	8.5	8.5	8.5	8.5	8.5
OPP (0.5)	8.0	8.5	8.0	8.3	8.3
OPP (1.0)	8.5	8.5	8.4	8.3	8.0
OPP (1.5)	8.0	8.5	8.0	8.3	8.3
OPP (2)	8.3	8.5	8.0	8.0	8.0
OPP(2.5)	8.0	8.5	8.3	8.3	8.3
OPP(3)	8.3	8.5	8.4	8.5	8.5
OPP (3.5)	8.0	8.5	7.5	7.5	7.5
OPP (4)	8.0	8.5	7.0	7.0	7.0
Mean	**8.17**	**8.5**	**8.01**	**8.07**	**8.04**

OPP = Orange peel powder.

Table 7
Testing of physical parameters.

Sr.No	Timing	Thickness(T)	Diameter(D)	Weight (mg)	Spread ratio
1	Before baking	1.0	4.9	20.34	4.9
2	After baking	1.4	6.5	20.34	4.5

Fig. 3. Prepared cookies before baking.

Fig. 4. Prepared cookies after baking.

Fig. 5. Packaging of cookies.

CRediT authorship contribution statement

Teke Nikita Vilas: Data curation, Investigation. **Patil Karuna Wasudeo:** Data curation, Investigation. **Gavit Hemangi Jayram:** Visualization, Investigation.

Data availability

Data will be made available on request.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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