DEVELOPMENT OF PEARL MILLET COOKIES INFUSED WITH MEDICINAL HERBS

Dissertation submitted to Mahatma Gandhi University in partial fulfillment of the requirements for the degree of

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B.Voc Food Processing Technology

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DECLARATION

We, **Tia Flemin CF (Reg.no. VB22FPT022), Emlin Seles Soshi (Reg.no. VB22FPT010), Nahan Sham (Reg.no.VB22FPT014),** hereby declare that this project entitled **"Development of Pearl millet cookies infused with Medicinal herbs"** is a Bonafide record of the project work done by us during the course study and that the report has not previously formed the basis for the award to us for any degree, diploma, fellowship or other title of any other university or society.

PLACE:

DATE:

Tia Flemin CF

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CERTIFICATION

This is to certify that the project report entitled **"Development of Pearl millet cookies infused with Medicinal herbs"** submitted in partial fulfilment of the requirements for the award of the degree of B.Voc Food Processing Technology of St. Teresa's College, Ernakulam is a record of Bonafide research work carried out by **Ms. Tia Flemin CF, Ms. Emlin Seles Soshi and Ms. Nahan Sham** under my guidance and supervision and that no part of the project has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journal or magazine.

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ABSTRACT

This project aims to develop a nutritious Pearl millet cookie infused with medicinal herbs like Tulsi (*Ocimum sanctum*) and Indian borage (*Plectranthus amboinicus*). The cookie offers a healthy alternative to traditional snacks, especially to the health-conscious generation. Rich in fiber, antioxidants, and essential minerals, this innovative product combines the nutritional benefits of pearl millet with the medicinal properties of Tulsi and Indian borage.

According to the sensory evaluation, sample with more concentration of herbs (5% herbs) was preferred. This sample was taken for physical and chemical analysis. According to the proximate analysis, the sample contained high fibre, energy, calcium and other nutrients compared to the control cookie.

The cookie's development involves optimizing ingredient ratios, evaluating nutritional content, and assessing consumer acceptability. In today's world, the word sustainability has its importance in the development processes. Therefore, making food products from underutilized products which are abundant in nutrients was the main goal and to further support sustainability. This project promises to provide a wholesome, nutritious snack option that promotes health and well-being.

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LIST OF ABBREVATIONS USED

ABBREVATION	TERM
g	Gram
Kg	Kilogram
Kcal	Kilo calories
mg	Milligram
cm	Centimeter
wt	weight
ml	Millilitre
&	And
%	Percentage
℃	Degree Celsius
α	Alpha
i.e.	That is
etc.	etcetera
et.al,	And others

CHAPTER 1

INTRODUCTION

Bakery products occupy an important place in the food industry. The annual growth of the bakery industry is increasing, and the demand for bakery products is growing among all sections of people. In India, bread, Cookies, and biscuits are a major part of the bakery industry and cover around 80% of total bakery products (Goswami et al., 2020). Cookies are one of the most popular bakery products among various bakeries products. (Yousaf et al., 2013). Cookies, also known as eyefuls in America, are extensively consumed worldwide by adults and children. Cookies are a popular foodstuff consumed by a wide range of populations due to their varied taste, and fairly low cost. (Hooda and Jood, 2005, Tyagi et al., 2007).

Cookies are small, sweet baked products usually made with refined flour, eggs, sugar, and butter or fat. Optional ingredients such as raisins, oats, chocolate chips, or nuts can also be added. Both machine-based and manual preparation methods are used. Cookies are convenient, ready-to-eat snacks often enjoyed during morning and evening tea. A nutritious and affordable alternative is herbal cookies made with plant powders, which can help boost immunity. (Upadhyay et al.,2017). Because of competition in the request and increased demand for healthy, natural, and functional products, attempts are being made to modify their nutritional composition by modifying cookies' nutritional value and functionality. Similar goods are veritably frequently achieved by adding the rates of wholegrain raw accouterments other than wheat or different types of salutary fiber in introductory fashions with the attempt to increase biscuit's protein content and quality, mineral content, and vacuity (Hooda and Jood, 2005, Tyagi et al., 2007).

Millets are edible kernels, produced by small grass-like plants of the Poaceae family, offering remarkable nutritional benefits along with medicinal advantages. (Joshi and Agnihotri 1984; Yenagi et al., 2010). They are rich sources of minerals and vitamins and exhibit a unique nutritional profile characterized by low fat and low glycemic index, providing numerous health benefits. (Singh & Raghuvanshi, 2012). The outstanding features of millets make them a key crop to withstand climatic challenges, facilitating innovative climate-resilient technologies. The current lifestyle associated with several health issues has made it crucial for people to depend on nutritious and healthy diets. Millets, being a rich source of proteins and nutrients, provide a nutritious solution that meets the demands of the current lifestyle. (Dwivedi et al.,2012; Kam et al., 2016).

Globally, pearl millet (*Pennisetum glaucum*) ranks as the sixth most significant cereal crop, and within tropical cereals, it holds the fourth position, following rice, maize, and sorghum in importance. (Bonamigo, 1999; Harinarayana et al., 1999). It is a highly resilient cereal crop renowned for its exceptional drought tolerance, thriving in areas with limited rainfall. It is extensively cultivated in countries such as Ethiopia, India, Pakistan, and several African nations. With a remarkably short cultivation period of 88-96 days, pe'arl millet is an ideal crop for rotation

programs. In India, pearl millet is cultivated on an impressive 13.64 million hectares, accounting for 30% of global production and yielding over 7 million tons of grain annually. From a nutritional standpoint, pearl millet grain is exceptionally rich, boasting 11.6% protein, 2.3% minerals, and 1.2% fiber, thereby surpassing rice, maize, and sorghum in protein and mineral content. Pearl millet is a nutritious grain that possesses several functional properties, making it a valuable ingredient in various food and beverage formulations. Among its prominent attributes is its remarkable water and oil absorption capacity, a crucial characteristic for dough hydration and texture enhancement in baked goods (Meena et al., 2024). In addition, it has abundant nutrients and can be consumed by people suffering from coeliac diseases due to its gluten-free nature (Pessanha et al., 2023, Selladurai et al., 2023). The nutrient and health-promoting aspects of Pearl millet can be utilized to manufacture several bakery products (Satyavathi et al., 2021).

Plant-based medicines are now commonly utilized in various public health practices globally due to their safety, cost-effectiveness, and ability to effectively fight against numerous serious diseases while promoting overall health. (Swamy et al., 2011). Herbal remedies have been extensively used in Unani, Ayurveda, Siddha, folk medicine, and other traditional medical systems. (Swamy et al., 2015).

Indian borage (*Plectranthus amboinicus*) is an aromatic medicinal herb extensively employed in Ayurvedic medicine, and is a member of the Lamiaceae family (Kirtikar & Basu, 1999). Indian Borage is combined with mouthwash to inhibit bacterial growth in the mouth because of the presence of carvacrol. (Santos et al., 2015). Coughs are managed using an infusion or syrup prepared from the fragrant leaves of Indian Borage. Additionally, the oils extracted from this plant are utilized in aromatherapy at numerous health and wellness spas globally (Arumughan et al., 2013). In cases of diarrhea caused by infections, the leaves of this plant is consumed along with buttermilk, yogurt, and other dairy items. (Damanik et al., 2006) P. amboinicus leaves prevent the growth of pathogens such as E. coli and Salmonella typhimurium. (Muniandy et al., 2014).

Tulsi (*Ocimum sanctum*), a medicinal plant used since ancient times, is well-recognized for its health advantages. In the Ayurvedic tradition, Tulsi is often called a "Solution of Life" due to its medicinal benefits and has been utilized to address various common health problems. Holy basil, commonly called tulsi (OS Linn), has been used globally to treat various ailments. (Dhandayuthapani S et al., 2015). The Tulsi plant is highly effective in preventing and treating cancer due to its chemopreventive and radioprotective qualities. (Baliga MS et al.,2013). It shows anti-oxidative and anti-hyperlipidemia effects in combating hypercholesterolemia. (Suanarunsawat T et al., 2010). Tulsi leaf extract (DTLE) provides protection against genotoxic agents. (Dutta D et al.,2007). Consuming tulsi leaf (OS Linn.) on an empty stomach enhances immunity. (Mondal S et al., 2011). The antioxidant characteristics of OS play a role in its ability to reduce stress. (Jyoti S et al., 2007). OS (Tulsi) can be utilized to address cognitive disorders such as dementia and Alzheimer's disease. (Joshi H et al., 2006)

Incorporation of nutritious ingredients calls for modification in original product formula, thus creating a new product with higher nutritional benefits. Such fortification of baked formulations offers a greater variety in taste and textures that are uniquely different from their conventional counterparts along with enhanced protein, vitamin and mineral contents and beneficial effects on its quality (Karadzhov & Iserliyska, 2003, Murugkar, 2020). Cookies are not only suitable bioactive and nutritional compounds delivering food products into human diet but also ideal for nutrient availability, palatability, compactness and convenience (Jadhav et al., 2021). This study involves formulating cookies using millets and medicinal herbs while evaluating their shelf life, nutritional value, sensory characteristics, and degree of acceptance.

1.1 SCOPE

In recent years, foods with medicinal benefits have gained immense popularity. People worldwide are seeking healthier options without drastically altering their usual dietary patterns (Thorat et al., 2017). Despite the demand for luxurious foods, consumers are increasingly opting for healthy diet options (Crofton et al., 2013). Cookies with low calories, a low glycemic index, high fiber content, and high nutrient value attract a larger consumer base. Herbal cookies, made by incorporating powders of medicinal plants into millet flour, can positively impact the nutritional and sensory attributes of the product. Incorporating healthy ingredients into everyday foods creates new market opportunities for food manufacturers (Krutulyte et al., 2011).

1.2 OBJECTIVES

- To explore the incorporation of functional ingredients into traditional foods, enabling the development of innovative products and enhancing market presence.
- To formulate cookies with a low glycemic index, high protein content, elevated nutritional value, and reduced calorie count, catering to health-conscious consumers.
- To meet the growing demand for wholesome, nutritious snack options by offering a product that aligns with consumer preferences for healthy and balanced foods.

CHAPTER 2

REVIEW OF LITERATURE

2.1 COOKIES

Cookies are confections that are enjoyed by consumers, particularly kids, and have a long shelf life. Globally cookies market has been boosted up and expected to index the Compounded Annual Rate of Growth of 4.1 percentage during the years of 2018 to 2023 (Gunaseelan and Arun, 2021). The cookie is a baked product that can be made using non-wheat ingredients that have been enhanced with nutrients and wheat flour. Small and delicious, cookies often contain sugar, eggs, refined flour, and either butter or oil. It might contain additional components such nuts, chocolate chips, oats, or raisins. Cookies and cookies differ slightly in terms of the proportion of raw ingredients, production processes, and both internal and outward characteristics. Either a machine or a hand is used to prepare the cookies.

According to Manley (2000), cookies can be classified as cabin cookies, semi-sweet and hard-sweet cookies, and sugar-snap cookies. Despite being mostly composed of carbohydrates, most cookies on the market do contain some nutrients that the body may utilize. Most cookies are frequently deficient in protein and of poor nutritional quality. Achieving protein balance and quality can be facilitated by combining cereals and legumes. It is well recognized that certain carrier products may influence consumers' acceptance and willingness to try certain functional foods, depending on the type of enrichment. The marketing of functional foods with sensory attributes comparable to those of conventional products may be made easier by the feasibility of adding therapeutic herbs to cookies, according to the sensory results.

Better marketing opportunities are presented to food businesses when new foods are developed by incorporating functional ingredients into a carrier food, like cookies. (Krutulyte, 2011). On the other hand, adding functional elements may cause the sensory quality to decline, which would decrease customer preferences. (Glanz et al., 1998) According to several scientists (Westenhoefer et al., 1993), consumers are rarely prepared to forgo the flavor of functional meals in exchange for potential health advantages.

Two broad terms can be used to describe cookie quality. The first is the cookie's dimensions, including its height and width. One crucial quality metric is the finished cookie's diameter (Doescher et al., 1987). The cookie's bite is the second. High-quality cookies bite tenderly (Hoseney, 1994). The cookie's structure determines the bite. To create dough, flour serves as the matrix around which different amounts of additional toughening or tenderizing components are combined (Tanilli, 1976).

It is important to remember that the baking qualities of flour vary with age (Miller and Hoseney, 1997) and that this does not necessarily translate into better baked goods. Compared to cookies made with control flour, those made with defatted flour had a more rigid microstructure (Papantoniou et al., 2004) and were noticeably tougher (Papantoniou et al., 2003).

The diameters of cookies made with flours that have had the lipids extracted are smaller than those made with flours that have not been extracted. When they come out of the oven, all cookies are soft and somewhat pliable, with the exception of those that have been dried to a very low moisture content. They become brittle and stiff over time. Slow crystallization of sucrose from concentrated sugar syrup generated during the earlier phases of processing has been related to the ongoing texture change and formation of the final crispness (Curley and Hoseney, 1984). Much of it crystallizes when it cools, which significantly alters the cooked cookie's texture. (Manley, 2000).

After sucrose crystallizes, it loses its ability to influence the system's water activity and function as a solvent. Additionally, cookies grow softer when soaked in water because hydrogen bonds are disrupted in the presence of water (Hoseney and Rogers, 1994). Compared to cakes and bread, cookies are less moist and rely more on fat for mouthfeel and tenderness (Lai and Lin, 2006). The primary component that holds the other ingredients in the dough together is fat. This explains why managing dough consistency is so dependent on the temperature of the dough and how the fat is prepared.

According to Wade (1988), adding fat to dough has the dual benefits of making the finished product softer to eat and lowering the amount of water needed to get a workable consistency. In general, cookie manufacturing is thought to be a rather easy process. The well-known treats that we all eat with tea or coffee or as a snack simply require a small amount of time and a few components (flour, sugar, fat, water, and leavening agents). In actuality, the process of turning the materials into a cookie involves several intricate (bio)chemical and physical procedures that, despite being observed by numerous researchers, remain incompletely understood and hence cannot be fully explained.

2.1.1 TYPES OF COOKIES

COOKIES WITH DIETARY RESTRICTIONS

1. Vegan cookies: Made using plant-based milk and egg replacements instead of animal components.
2. Dairy-free cookies: Made with non-dairy milk and chocolate that is free of dairy.
3. Gluten-free cookies: Suitable for people with celiac disease or gluten intolerance, these cookies are made with gluten-free flours.
4. Sugar-free cookies: Made with natural sweeteners like honey or maple syrup or sugar replacements.

COOKIES BY INGREDIENT

1. Herb-infused cookies: For distinctive flavors and possible health advantages, try herbs like panikoorka, thulsi, or rose petals.
2. Nut-based cookies: These cookies are made with nuts, such as pecans, walnuts, or almonds, to provide flavor and texture.
3. Seed-based cookies: For extra texture and nutrition, use seeds like hemp, chia, or flaxseed.

4. Fruit-based cookies: These cookies are sweetened and flavored with fresh or dried fruits, such as apples, raisins, or cranberries.

COOKIES BASED ON TEXTURE

1. Crunchy cookies: These cookies have a crunchy texture because they contain components like nuts or seeds.
2. Chewy cookies: These cookies have a chewy feel and are made with substances like corn syrup or honey.
3. delicate-baked cookies: These have a delicate, tender feel and are made with ingredients like Greek yogurt or brown sugar

COOKIES BASED ON HEALTH FUNCTION

1. Protein cookies: A great post-workout snack made with protein-rich ingredients like peanut butter or protein powder.
2. Energy cookies: For a quick pick-me-up, these cookies are made with components that enhance energy, such as oats, almonds, or seeds.
3. Raw cookies: For a healthier alternative, make these cookies with raw ingredients like cocoa nibs, almond flour, or coconut sugar.

Table 2.1: Types of Cookies

COOKIES BASED ON :			
Diet restrictions	**Ingredients**	**Texture**	**Health function**
Vegan cookie	Herb-infused cookie	Crunchy cookie	Protein cookie
Dairy-free cookie	Nut-based cookie	Chewy cookie	Energy cookie
Gluten-free cookie	Seed-based cookie	Delicate-baked cookie	Raw cookie
Sugar free cookie	Fruit based cookie		

2.2 MILLETS

Millets are products of small grass plants that belong to the *Poaceae* family. They are round shaped, small seeded cereals (FAO, 2020). The term "millet" is derived from the French word "mile," signifying thousand, which describes the abundance of grains in a small quantity. Generally, there are over 20 types of millets characterized by differences in size, shape, and geographic distribution. Common varieties including pearl, finger, foxtail, proso, and barnyard

millets. Millets are an ancient food source that's been cultivated for centuries. They are a major food source worldwide, especially in most regions of Africa and Asia. Millets are plants that exhibit exceptional photosynthetic efficiency, coupled with a short growth cycle, high dry matter production capacity, and remarkable tolerance to heat and drought (Yadav & Rai 2013).

Their high nutritional value and agricultural importance make millets particularly significant (Saleh et al., 2018). Millets typically comprise 65-75% carbohydrates, 7-12% protein, 2-5% fat, and 15-20% dietary fiber, along with notable amounts of vitamins, minerals, and phenolic compounds (Hasan et al., 2019; Srilekha et al., 2019). Millets contain bioactive compounds that possess antioxidant and antimicrobial activities, which may contribute to improved health outcomes (Singh & Sarita, 2016; Nazari et al., 2018). Most of them are rich in micronutrients and phytochemicals (Mal et al., 2010; Singh et al., 2012). Apart from their nutritive value, millets have been associated with various health benefits, including preventing heart diseases and cancer, reducing tumor incidence, maintaining blood pressure, improving cardiovascular health, and regulating cholesterol by increasing the rate of fat absorption.

Fig 2.1: Types of millets
Source: https://unsplash.com

2.3 PEARL MILLET (BAJRA)

Pearl millet (*Pennisetum glaucum*) known as Bajra in India, is a significant crop globally, ranking sixth in terms of production volume, following maize, wheat, rice, barley, and sorghum (FAOSTAT, 2014). It is a resourceful cereal crop cultivated for various purposes, including human consumption, animal feed, and fodder (Arora et al., 2003), primarily in African and Asian regions (Nambiar et al., 2011). It is also recognized as a crop that offers significant economic and nutritional benefits to small-scale farmers (Patel K, et al., 2015), thereby contributing to their livelihoods and food security.

Pearl millet is a crop characterized by its remarkable height, which can range from 8 to 16 feet. Bajra is a C4 plant distinguished by its exceptionally high photosynthetic efficiency, remarkable dry matter production capacity, short growth cycle, and impressive heat tolerance. Furthermore, it exhibits adaptability to challenging soil conditions, including acidic, saline, and aluminum toxic soils (Yadav and Rai, 2013). Due to their ability to withstand adverse climate conditions, including unpredictable weather and nutrient-deficient soils, pearl millets are regarded as robust crops. Also, pearl millets possess remarkable drought tolerance, thereby enhancing their potential for cultivation in regions where other cereal crops, such as wheat and maize, struggle to survive (Sharma KK., 2000).

According to some studies, pearl millet is likely to have originated from the sub-Saharan African region 5000 years ago (Gari J A., 2002) and was introduced to the Indian subcontinent around 3000 years ago. Pearl millet is the most widely cultivated millet variety, covering an area of over 29 million hectares. However, its geographical distribution is largely confined to Africa and Asia. Notably, more than 95% of global pearl millet production originates from developing countries, with India being the largest producer (Basavaraj et al., 2010). Pearl millet is the third most widely grown food crop in India, following rice and wheat. The major pearl millet-producing states in the country are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, and Haryana.

2.3.1 PHYTOCHEMICAL PROFILE

Pearl millet is a rich source of phytochemicals. Carotenoids and phenolic compounds represent the most significant and valuable components of phytochemicals found in whole grains (Liu contribute 2007). These phytochemicals contribute significantly to protecting overall human health and well-being (Taylor et al., 2014). Flavonoids possess anti-inflammatory and antioxidant activities which results in a healthy body (Song et al., 2011).

2.3.2 NUTRITIONAL COMPOSITION

Bajra is a nutrient-dense millet characterized by its high metabolizable energy, comprising carbohydrates (60-70%), proteins (11.6%), and fats (5-7%). It is a rich source of phytochemicals and micronutrients such as B complex, vitamin E, Folic acid, and minerals like potassium, magnesium, calcium, phosphorous, copper, and other minerals with oxalic acid within safe limits. Due to its lower hydrocyanic acid content, Pearl millet is an excellent forage crop. Studies in India have shown that pearl millet overtakes maize and rice in terms of nutritional quality, based on

feeding trials conducted in the country (NRC, 1996; DeVries & Toenniessen, 2001). They have high concentrations of zinc and iron, as well as a more balanced amino acid content, surpassing that of maize and sorghum (Rai KN., et al., 2008). Pearl millet has high levels of healthy unsaturated fats (75%) and linoleic acid (46.3%) content (Jaybhaye et al., 2014). Bajra grains are gluten-free and the biological value of its protein is higher than wheat. Grain has no tannin and contains oil (5–7%).

Table 2.2: Proximate analysis of pearl millet (g/100 g)

Nutrients	**Value**
Moisture	12.4
Protein	11.6-11.8
Fat	4.8-5
Dietary Fiber	11.3
Carbohydrates	67-67.5
Energy	17
Minerals	2.2-2.3

Source: Amadou I, et al., 2013

Table 2.3: Mineral analysis of Pearl millet (mg)

Minerals	**Value**
Phosphorus	296
Potassium	307
Magnesium	137
Calcium	42
Sodium	10.9
Zinc	3.1
Iron	8.0
Manganese	1.15
Copper	1.06

Source: Amadou I, et al., 2013

2.3.3 ANTI-NUTRITIONAL FACTORS

Apart from its desirable nutritional properties, pearl millet (bajra) is also found to contain certain anti-nutritional factors, including polyphenols, tannins, and phytates (Ranasalva and Visvanathan, 2014). The presence of these anti-nutritional factors results in the chelation of essential minerals in the gastrointestinal tract, leading to a reduction in their bioavailability (Nour et al., 2014). Furthermore, the presence of polyphenolic pigments in the pericarp, aleurone, and endosperm layers of pearl millet may lead to the formation of an unappealing grey color and unpleasant taste in the final product (Rathi et al., 2004). The occurrence of lipase activity in grains is another factor that can contribute to the formation of undesirable odors and flavors, which can compromise the sensory quality of the final product.

2.3.4 HEALTH BENEFITS

The chemical constituents present in Bajra have been found to possess various health-promoting activities, which contribute to its potential benefits for human health. Among all the millets, pearl millet is distinguished by its exceptionally high iron content, making it an excellent dietary supplement to counteract iron deficiency. Notably, high micronutrient-density hybrids of pearl millet have been developed and released in India, further enhancing its nutritional value (Vinoth and Ravindhran 2017). The minerals present in bajra are suitable for maintaining cholesterol levels and heart-related problems. Unsaturated fats and high calcium in grains are responsible for great health. The high fiber content of pearl millet is helpful for people dealing with problems of constipation and obesity. Pearl millet is packed with antioxidants, especially phenolic compounds, which may help fight cancer.

According to Mani et al., (1993), Pearl millet has low glycemic index (55), which helps in managing diabetes. Fatty acids present in pearl millet have been found to have a positive impact on various aspects of human health, including the reduction of blood triglycerides, boosting of immune function, improvement of brain and eye function, and support for infant development (Kinsella et al, 1990; Simopoulos, 2000).

2.4 INCORPORATION OF HERBS IN COOKIES

The fields of functional foods and herbal medicine have grown rapidly in the past several years. Everywhere, people want to consume a healthy diet without altering their traditional eating habits (Thorat et al., 2017). An alternative to traditional cookies are cookies made with herbs.One may classify cookies as convenient and ready-to-eat foods. For tea time snacks in the morning and evening, they are well-liked. Another way to boost immunity is to make inexpensive, nutrient-dense cookies using plant powder and herbal ingredients (Upadhyay et al., 2017).Herbs are therapeutic plants that contain active ingredients that prevent microorganisms from growing, hence reducing health issues (Kukreja et al., 2001).

By preventing fat from oxidizing, the addition of herbal extracts to shortbread cookies may enhance their sensory qualities and increase their shelf life. The results of this investigation demonstrated that cookies enhanced with fewer herbal extracts had higher lightness values than samples with more extract additions. Functional processed foods have supplanted conventional processed foods (Upadhyay et al., 2017). Manufacturing a herbal cookie with natural components and herbal plants is one way to get around these issues. Therefore, creating such nutrient-dense cookies offers consumers the opportunity to save money and preparation time. Additionally, it will provide quick access to high-nutrient herbal food that is enhanced with herbal value and has positive health effects including lowering blood pressure and fighting cancer. At the same time, it is convenient to eat whenever and wherever most youngsters like.

Since cookies are typically made with wheat flour, oil, and sugar, they are regarded as an energy source (Mancebo et al., 2015). However, traditional cookies are deemed unhealthy due to their lack of fiber, phytochemicals, and other nutrients (Ismail et al., 2014). Recent studies have focused on fortifying cookies with various dietary items or plant materials that are regarded as rich sources of nutrients and phytochemicals in order to get around these restrictions (Ganorkar et al., 2014). Demands from consumers for foods with greater health benefits beyond those of general nutrition have grown recently. As a result, there is a growing trend of fortifying foods or creating novel food items with health-promoting qualities such antioxidant, anti-inflammatory, anti-cancer, and antidiabetic activities (Bhat et al., 2020).

Worldwide research and commercialization have focused on medicinal herbs that contain bioactive chemicals with therapeutic qualities (Oliveira et al, 2009). Most of these research concentrate on organic substances that serve a variety of purposes within the body. Since these plants can provide a substantial amount of physiologically active compounds such as antioxidants, antimutagens, and anticarcinogens, it is intriguing to employ them as a food supplement given their rising consumption (Dillard et al, 2000). Because people are more concerned about their health and diet these days, cookies made solely of wheat might not be the healthiest option, which is why functional and herbal foods are becoming more popular (Kwak et al, 2001). Due to the growing trend of using herbal products for wellness, manufacturers have recently refocused their attention on using herbs in traditional foods like tea, juices, and snack chips by using terms like "special diet foods," "medical foods," and "dietary supplements" (Kwak et al, 2001). Functional foods, as defined by the Food and Drug Administration, include natural or added nutrients that offer health advantages beyond the food's conventional nutritional value (Zhou et al, 2014). The FDA and other regulatory agencies do not have a regulatory category for functional foods like they do for conventional foods; nonetheless, herbal ingredients must be approved as GRAS in order to be utilized in functional foods (Robert et al, 2006).

2.5 COMMON HERBS USED IN FOOD PRODUCTS

Herbs have been used in food since long time for its health benefits, sensory properties and culinary importance. Herbs used in food are of different categories: aromatic, culinary, medicinal, ornamental, etc. Ashwagandha or Indian ginseng is a medicinal herb used in food for its unique flavor and health benefits. *Bacopa monniera* or Brahmi has various health benefits. Other herbs used in food include: Basil (*Ocimum basilicum*), Coriander (*Coriandrum sativum*), Dill (*Anethum graveolens*), Lemongrass (*Cymbopogon citratus*), Oregano (*Origanum vulgare*), Parsley (*Petroselinum crispum*), Rosemary (Rosmarinus officinalis), etc. (Kaefer and Milner, 2008).

2.6 INDIAN BORAGE (MEXICAN MINT)

Plectranthus amboinicus, commonly referred to as Indian or country borage, is a significant aromatic herb belonging to the Laminaceae family, extensively cultivated in India and Southeast Asia for its traditional medicinal properties. Indian Borage is known by various names globally, including Spanish thyme, Cuban oregano, Oregano brujo (in Puerto Rico), Mexican thyme, and Mexican mint (Prakash et al., 2012). Additionally, *P. amboinicus* is native to the United States, where it originated as a shrub (USDANRCS, 2014). It is also a pretty tough plant - it can handle drought and even grow in colder temperatures (Staughton, 2020).

Indian borage is a succulent perennial herb, characterized by its leaves bearing fine, tender hairs that impart a distinctive aroma, thereby maintaining its unique position (Wagner & Lorence, 2014; Prasad et al., 2020). The leaves are an excellent source of essential vitamins and minerals, accompanied by a wide range of bioactive, non-nutritive compounds, including antioxidants, total phenolic, and dietary fibers, which play a crucial role in maintaining overall health and well-being. The perfect conditions for the growth of *P. amboinicus* comprise organically rich soil, high levels of humidity, and a neutral pH, which collectively provide an ideal environment for the plant's development. The leaves, whether fresh or dried, are a popular culinary ingredient globally, employed for their flavoring, seasoning, and condiment properties, enhancing the taste and aroma of dishes.

2.6.1 NUTRITIONAL COMPOSITION

P. amboinicus is a nutrient-dense herb that serves as a valuable supplement in the human diet, boasting high levels of minerals such as calcium and potassium, as well as other beneficial compounds like zeaxanthin, neoxanthin, leptin, violaxanthin, and carotene (Lukhoba et al., 2006). It is a nutrient-rich plant characterized by its rich composition of nutrients including carbohydrates, proteins, lipids, and fiber, as well as micronutrients, such as vitamins A, B complex, and C, and essential minerals like calcium, iron, magnesium, phosphorus, potassium, etc. The iron content in

P. amboinicus is quite significant. Carvacrol present in Indian borage helps in enhancing the shelf life and taste of food. It also contains essential oils, flavonoids, and terpenes, which have been shown to exhibit inhibitory effects against both Gram-positive and Gram-negative bacteria, as demonstrated by P. Bhatt and P. S. Negi (2012).

Table 2.4: Nutritional analysis of Indian Borage

Nutrients	**Value**
Ash (g)	1.43
Moisture (g)	93
Energy (kcal)	211
Carbohydrate (g)	3.05
Protein (g)	1.79
Lipid (g)	0.69
Fiber (g)	45.38
Calcium (mg)	93
Iron (mg)	3.3
Magnesium (mg)	51.68
Potassium (mg)	469.6
Vitamin A (IU)	4200
Vitamin C (mg)	35.05

Source: Pereira et al., (2011); Pilerood & Prakash (2014); USDA (2019); Staughton (2020)

2.6.2 HEALTH BENEFITS

Plant-based medications have gained widespread acceptance in public health practices worldwide, due to their safety profile, affordability, and ability to effectively manage various diseases, as well as maintain good health (Swamy et al., 2011). The leaves of *P. amboinicus* are primarily utilized in the treatment of various health conditions, including stomach disorders, asthma, epilepsy, and renal diseases, and have been reported to possess antioxidant and antimicrobial properties. It also has been traditionally employed in the treatment of various health

conditions, including malaria, inflammation, cough, chronic asthma, bronchitis, liver disorders, kidney stones, and gallstones (Kaliappan & Viswanathan, 2008).

The minerals which are present improves bone strength and also enhances the function of some important organs like the kidney, heart, nerves and muscles. According to R.S. Khare et al. (2011), the plant possesses a wide range of pharmacological properties, including antiepileptic, antimutagenic, radioprotective, neuropharmacological, and antimicrobial activities. Indian borage contains linoleic acid, which has been found to reduce arthritis pain by promoting joint regeneration, and its high levels of ascorbic acid make it an effective immune system booster (Staughton, 2020). Indian Borage is a natural way to keep your mouth healthy, as it contains carvacrol, a compound that helps prevent bacterial growth and promote oral wellness (Santos et al., 2015).

Fig 2.2 Holy basil

Fig 2.3 Indian borage

Source: https://unsplash.com

2.7 TULSI (HOLY BASIL)

Holy basil (*Ocimum sanctum*), a member of the Lamiceae family, is a highly valued annual herbaceous plant in Southeast Asian cuisine, featuring slightly hairy, pale green leaves that add a spicy, lemony flavor to various dishes (Uhl, 1996). This perennial shrub typically grows to be 30–60 cm tall and has a short lifespan (Watt, 1972). Globally, the shrub is cultivated for its versatile uses, including perfumery, medicinal, religious, culinary, ceremonial, and essential oil applications (Nadkarni, 1976).

Holy basil is an integral part of traditional medicine systems like Siddha, Ayurveda, and Traditional Chinese Medicine, where its therapeutic properties and numerous health benefits are highly valued (Singh & Majumdar, 2019). There are three main types of tulsi, with *Ocimum tenuiflorum* comprising two distinct cultivars: Rama or Shri tulsi (green leaves) and Krishna or Shyama tulsi (purplish leaves), while *Ocimum gratissimum* is known as Vana or wild/forest Tulsi

(dark green leaves). Herbal healers believe that the dark variety of Tulsi has more potent medicinal effects compared to the green variety (Prakash P & Gupta N, 2005)

2.7.1 NUTRITIONAL COMPOSITION

Recent studies on the nutraceutical properties of Tulsi have shown that it is an excellent source of essential nutrients, including vitamins, minerals, proteins, polysaccharides, fats, pigments, fiber, and mucilage (Pattanayak et al., 2010; Koche et al., 2011; Vidhani et al., 2016; Gowrishankar et al., 2010; Pachkore and Dhale, 2012). The essential oil present in tulsi is a notable feature and it is also a good source of eugenol. Eugenol has been found to exhibit analgesic, antimicrobial, and anti-inflammatory properties, making it a valuable compound (Mukherjee et al., 2007). Other bioactive compounds present in tulsi includes rosmarinic acid flavonoids, and ocimumosides (Cohen, 2014; Singh & Majumdar, 2019). Studies have revealed that rosmarinic acid exhibits anti-inflammatory and antioxidant effects, reducing the risk of oxidative stress and inflammation-related ailments (Bhattacharyya et al., 2021).

Table 2.5: Nutritional analysis of Holy Basil (100g)

Nutrients	Value
Energy	23 (kcal)
Protein	3.15 (g)
Carbohydrates	2.65 (g)
Total Fat	0.64 (g)
Dietary Fiber	1.60 (g)
Vitamin A	2.5 (mg)
Vitamin C	85 (mg)
Calcium	3.5 (mg)
Iron	2.3 (mg)

Source: Pradeep Dwivedi., et al., 2023

2.7.2 HEALTH BENEFITS

The phytochemicals present in holy basil contribute significantly to its therapeutic properties and overall health benefits. Since ancient times, tulsi was used to treat various health conditions, including common colds, coughs, oral conditions, bronchitis, and skin infections, in Ayurveda and Southeast Asian folk medicine (A. P. Committee,2016). Traditionally, the juice of tulsi leaves has been used as ear drops to relieve earaches, while the tea infusion has been employed to treat stomach and liver disorders (R. Chopra & I. Chopra, 1992). Holy basil is thought to improve mental clarity and cognitive function, which can help alleviate stress-related disorders like anxiety and depression (Seth et al., 2013). Additionally, holy basil has been shown to stimulate the production of digestive enzymes, reduce symptoms of bloating, increase appetite, reduce indigestion, and stomach cramps (Baliga et al., 2013).

2.8 GINGER POWDER

A common spice in cuisines all over the world, ginger (*Zingiber officinale*) belongs to the tropical and sub-tropical Zingiberaceae family. Ginger is also a valuable medicinal plant that is used in traditional medical systems worldwide to treat a variety of illnesses, including colds, headaches, rheumatic disorders, arthritis, and muscle soreness. Black ginger is said to offer therapeutic qualities that can treat a number of ailments, such as diabetes, peptic ulcers, gout, diarrhea, dysentery, allergies, asthma, and impotence (Dedov et al., 2002; Wang & Wang, 2005; Tapsell et al., 2006). (Toda et al. 2016). Ginger may be used to treat bacterial infections due to its antibacterial qualities (Tan and Vanitha 2004). Semwal et al. (Citation 2015). In Chinese traditional medicine, a ginger rhizome infusion with brown sugar is used to treat colds, and coughing is relieved by adding powdered ginger to scrambled eggs. Maghbooli et al. 2014, verified ginger powder's effectiveness in treating frequent migraine episodes and its resemblance to the antiepileptic medication. Dehydrated ginger in powder form is less susceptible to microbial contamination, making it a more stable product (Patel and Srinivasan 2004).

2.9 PALM SUGAR

Palm trees are environmentally beneficial crops that help restore damaged soil while using minimal water. Palm sugar originates from the sap of palm trees, which is harvested and processed into sugar. This sap is a liquid collected from the male flowers of the trees, a result of their natural metabolic processes (Pindyck, R.S. & D. Rubinfeld., New Jersey, 2001). Sucrose is the key sugar in cookie making. It adds sweetness, affects the texture and structure of the cookies, and helps to incorporate air into the fat during dough mixing. Sucrose also makes cookie dough less thick. (Maache-Rezzoug et al., 1998). Using palm sugar instead of regular sugar can make cookies moister, darker in color, and have a chewier texture. It can also improve the nutritional value and

overall sensory experience of the cookies. (Saputro et al., 2018; Tai et al., 2021; Nurhayati et al., 2022). When palm sugar is used in food products, the glycemic index tends to decrease, while the antioxidant activity increases. (Whelan et al., 2008; Tai et al.,2021).

2.10 FLAXSEED

Flaxseed, also known as Linseed (*Linum Usitatissimmum*), is a blue-flowering rabi crop. It is a member of Linaceae family. Various studies have revealed that flaxseed's unique nutritional content makes it a good dietary component. In India, it is also referred to as Jawas, Alsi, or Aksebija. (Jain & Ganorkar 2013). Flaxseed is a higly nutritious food that contains healthy chemicals, which have several health benefits, leading to its increased importance in recent years (Rubiar et al., 2010). Flaxseed is an excellent source of dietary fiber, comprising approximately 28% soluble and insoluble fibers, making it a nutrient-dense food (Morris, 2007). The anti-inflammatory, anti-diabetic, and antioxidant properties of flaxseed contributes to a reduced risk of developing cancer, heart disease, kidney disease, and bone diseases (Katare et al., 2012). As consumers increasingly seek out healthy food options, researchers have been working to develop nutritious and wholesome cookies using flaxseed flour, aiming to create a dietary fiber product that is rich in lignin and offers numerous health benefits.

2.11 ROSE PETALS

A vital component of the plant, the blossom contains a variety of natural antioxidants, including flavonoids, phenolic acids, and anthocyanin, in addition to other elements including vitamins and minerals (Kaisoon et al., 2012: Rop et al., 2012). In recent years, flowers have gained popularity all around the world as fresh, edible crops. (Bhargava, Ujala, and Kumari, 2021). Known as the "queen of flowers," the rose, which belongs to the Rosaceae family, is one of the most significant commercial flower harvests. For millennia, roses have had a profound cultural impact on religion, spirituality, economy, medicine, and aesthetics. For millennia, people from many cultures have used rose petals to produce candies, teas, wine, cakes, jams, and flavour extracts. (Liu et al., 2020; Ercişli and Eşitken, 2004; Ercişli, 2005). Roses' vivid colours and aromatic scent make them perfect for commercialization as fresh culinary crops. (Shin and Yang 2017). Roses have therapeutic properties that help with fever, heart issues, conjunctivitis, burns, coughs, skin disorders, and overall weakness. Rose may include high-gastronomic-value nutraceutical substances (Guiné et al., 2019; Flores-Martínez et al., 2018). Carotenoids, anthocyanins, polyphenols, and other antioxidants are abundant in rose petals, as are carbohydrates. (2017, Fernandes et al.)

THE STUDY IS MAINLY FOCUSING ON:

The objective of this study is to develop and evaluate Bajra cookie infused with medicinal herbs, leveraging the nutritional benefits of millets and the therapeutic properties of herbs, addressing the gap in traditional cookie products where herbs are rarely utilized. The study mainly focuses on their potential health benefits, their unique combination, and the product's acceptability, thereby contributing to the development of healthier and more nutritious cookie options.

CHAPTER – 3

MATERIALS AND METHODS

3.1 RAW-MATERIALS REQUIRED

The raw materials selected for the preparation of Bajra cookie infused with medicinal herbs were Bajra flour, Ginger powder, Tulsi powder, Indian borage powder, Rose petals (dried), Flaxseeds, Palm sugar, Brown sugar, Wheat flour, Cocoa powder, Vanilla essence, Butter, Milk and Baking powder. All the ingredients were procured from reputed sources.

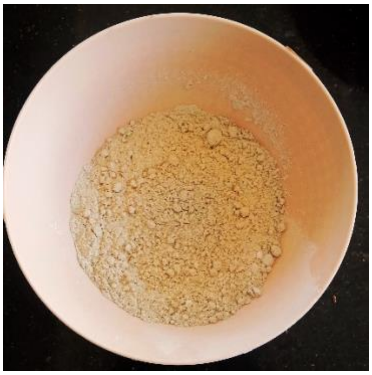

Fig 3.1: Bajra flour

Fig 3.2: Ginger powder

Fig 3.3: Tulsi powder

Fig 3.4: Indian borage powder

Fig 3.5: Rose petals

Fig 3.6: Flaxseeds

Fig 3.7: Palm sugar

Fig 3.8: Brown sugar

Fig 3.9: Wheat flour

Fig 3.10: Cocoa Powder

Fig 3.11: Vanilla essence

Fig 3.12: Butter

Fig 3.13: Milk

Fig 3.14: Baking powder

3.2 EQUIPMENTS

3.2.1 MIXER GRINDER

A mixer grinder is a versatile kitchen appliance that grinds, mixes, and blends food ingredients with ease. One of the main features of a mixer grinder is its ability to precisely and quickly grind culinary components. The speed of the equipment is adjustable.

3.2.2 MICROWAVE OVEN

A microwave oven is a kitchen appliance that uses electromagnetic waves, called microwaves, to heat and cook food quickly and efficiently. Microwave ovens are convenient, fast, and energy-efficient, making them a popular choice for many households.

3.2.3 HAND MIXER

Electric hand mixers also known as beaters are electric kitchen appliances designed for mixing, whipping, and beating ingredients. They're perfect for baking, whipping cream or eggs, and mixing sauces, dressings, and marinades. Electric beaters save time and effort, making food preparation more efficient and convenient.

3.2.4 WEIGHING MACHINE

Digital kitchen weighing machines are electronic devices that accurately measure ingredients weight in cooking and baking. They're ideal for precise measurements, reducing errors, and ensuring recipe consistency. With features like unit conversion (e.g., grams to ounces) and tare function, digital kitchen scales help home cooks and professional chefs achieve accurate ingredient ratios, making them a valuable tool in food preparation.

Fig 3.15: Mixer Grinder

Fig 3.16: Oven

Fig 3.17: Hand mixer

Fig 3.18: Weighing machine

3.3 SELECTION OF RAW MATERIALS

In this study, meticulous attention was given to the procurement of high quality raw materials to ensure the creation of a distinctive, nutritionally-rich cookie enriched with medicinal herbs. Premium-grade ingredients were sourced from reputable market sources, ensuring their optimal freshness and nutritional value.

3.4 PREPARATION OF RAW MATERIALS

3.4.1 PREPARATION OF GROUND FLAXSEED

Flaxseeds of excellent quality were measured and then crushed into a coarse texture using a mixer grinder.

3.4.2 PREPARATION OF POWDERED PALM SUGAR

Large crystals of palm sugar are ground to fine powder using a mixer grinder. Powdering palm sugar makes it easier to use in recipes, as it dissolves quickly and evenly.

3.5 PROCESSING METHOD

Cookies were prepared by combining the ingredients in 4 different ratios (Table 3.1) to find the appropriate combination. The ingredients for all the four samples (S1, S2, S3 and S4) were taken in different bowls. They were kneaded thoroughly and shaped.

After preparation finished product was further taken for physical and chemical analysis and sensory evaluation.

TABLE 3.1: Proportions of Cookies

Sample	Bajra	Wheat flour	Tulsi powder	Indian borage powder
S1 (controlled)	50g	30g	-	-
S2	46g	26g	1.5g	1.5g
S3	44g	23g	3g	3g
S4	43g	20g	5g	5g

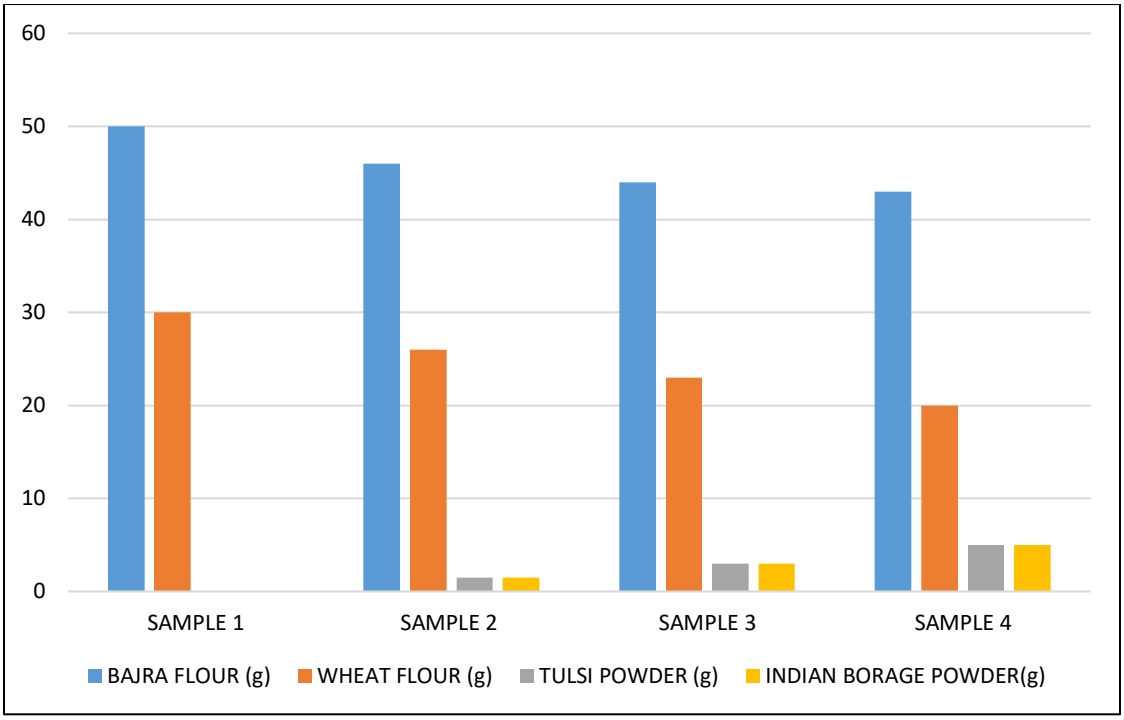

Fig 3.19: Formulation of cookies

The measurements of other ingredients were the same in all proportions:

Table 3.2: Measurement of other ingredients

Sl. No.	Ingredients	Measurement
1	Palm sugar	40g
2	Brown sugar	20g
3	Butter	25g
4	Baking powder	1g
5	Cocoa powder	2g
6	Milk	30g
7	Vanilla essence	2g
8	Ginger powder	2g
9	Flaxseeds	3g
10	Rose petals	2g

3.5.1 METHODOLOGY

The cookie preparation process involves several key steps. Firstly, baking trays are lined with parchment paper and all ingredients are accurately weighed and set aside. Subsequently, a wet mixture is prepared by combining butter, palm sugar, brown sugar, milk, and vanilla essence, while the dry ingredients (Bajra flour, Wheat flour, ground flaxseeds, Tulsi powder, Indian borage powder, Ginger powder, Cocoa powder, rose petals and Baking powder) are combined separately. The dry ingredients are then incorporated into the wet mixture, and the resulting mixture is kneaded to form a dough. The dough is then shaped into cookies, which are placed on the prepared baking trays. The cookies are baked in a pre-heated oven at 180°C for 15-20 minutes, after which they are cooled to room temperature.

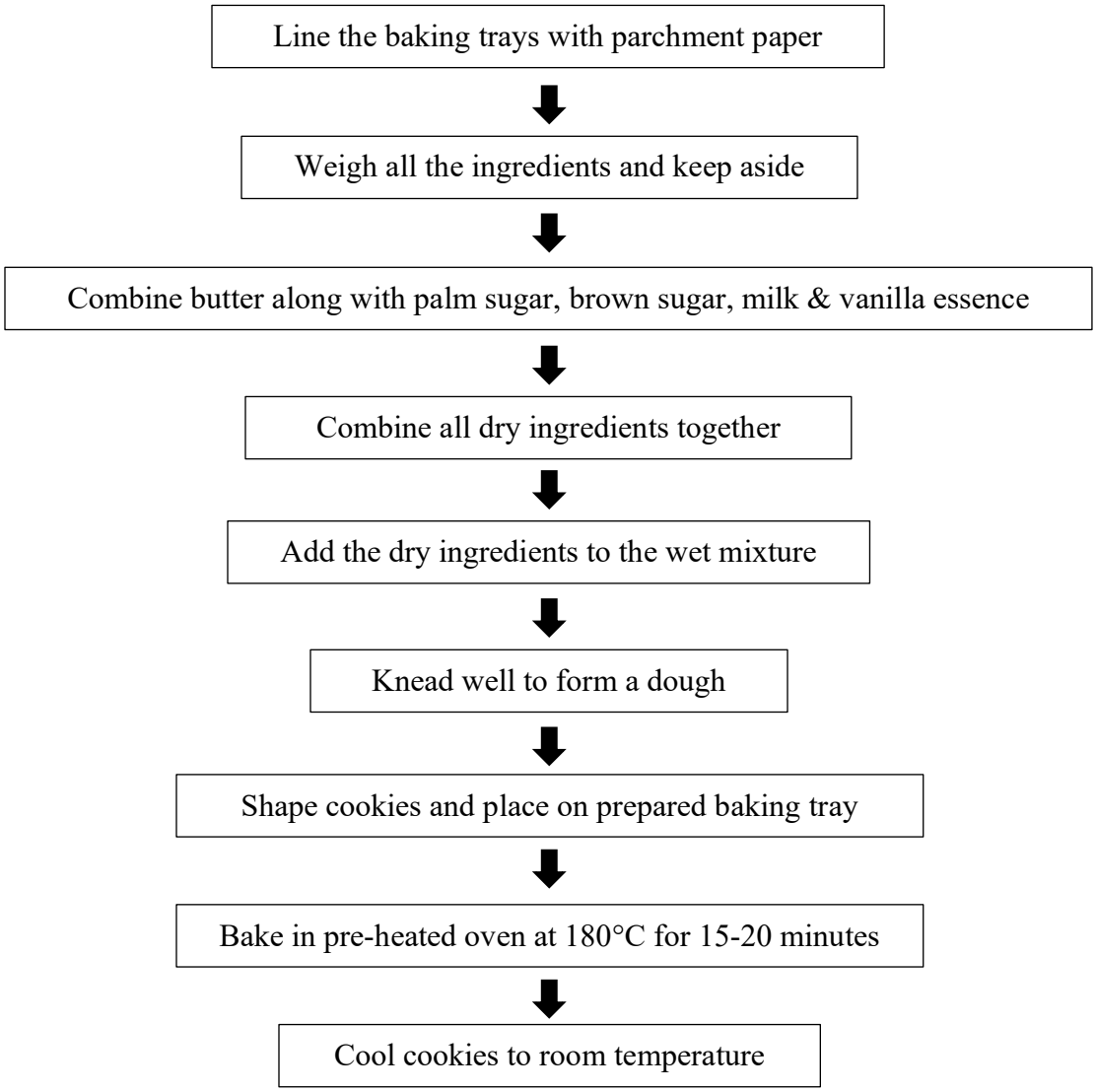

Fig 3.20: Process of cookie making

Fig 3.21: Sample 1 (Standard)

Fig 3.22: Sample 2 (1.5% herbs)

Fig 3.23: Sample 3 (3% herbs)

Fig 3.24: Sample 4 (5% herbs)

3.6 PHYSICAL ANALYSIS

3.6.1 DIAMETER

The diameter of the cookies was measured in mm using Vernier Caliper.

3.6.2 THICKNESS

The thickness of the cookies was measured in mm using Vernier Caliper.

3.6.3 VOLUME

Volume of cookie is defined as the area multiplied by thickness.

$$\text{Volume (cm}^3\text{)} = \frac{d^2\pi t}{4}$$

d = diameter of cookie (mm)
t = thickness of cookie (mm)

3.6.4 SPREAD RATIO

The spread ratio was determined by using this formula,

$$\text{Spread ratio} = \frac{Diameter}{Thickness}$$

Fig 3.25: Vernier Caliper

3.7 SENSORY EVALUATION

A Sensory assessment was done by a sensory panel of five trained and five semi trained panelists. These evaluators were provided with 5-point Hedonic scale score card to assess four different food samples (S1, S2, S3, S4) based on attributes: Appearance, aroma, taste, texture. Based on the sensory evaluation, one of the samples was selected for storage studies.

Table 3.3: Hedonic Rating scale

5-point Hedonic scale	
5	Like extremely
4	Like slightly
3	Neither like nor dislike
2	Dislike slightly
1	Dislike extremely

Fig 3.26: Sensory evaluation by Panelists

3.8 PROXIMATE ANALYSIS

3.8.1 MOISTURE CONTENT

Weigh accurately 10g of well mixed sample in a previously dried and tared dish. Place the dish in a vacuum oven and dry the material for 6 hours maintained at 80 ± 1°C at a pressure not exceeding 5 mm of mercury. Cool the dish to room temperature in a desiccator and weigh.

$$\text{Moisture (g/100g)} = \frac{100\ (M-M1)}{M}$$

Where, M = mass in g of sample taken for test

M1 = mass in g of material after drying

3.8.2 TOTAL ASH

Weigh accurately about 5g of the sample in a clean and dry porcelain dish. Ignite the sample in the dish with the flame of a suitable burner for about one hour. Complete the ignition by keeping in a muffle furnace at 550 ± 25°C for six hours until grey ash results. Cool in a desiccator and weigh. Repeat the process of igniting, cooling and weighing at half-hour intervals until the difference between two successive weighing is less than one milligram. Note the lowest mass.

CALCULATION

$$\text{Ash (g/100g)} = \frac{(M2-M1)\times 100}{M-M1}$$

Where, M = mass in g of dish and test portion

M1=mass in g of empty dish

M2 = mass in g of dish with ash

3.8.3 CRUDE FIBER

The determination of Crude fibre was done using the AOAC method.

PRINCIPLE

Crude fibre is the organic matter in the dried residue and is determined after digesting the sample with dilute sulphuric acid and sodium hydroxide. This method is applicable to all food products having crude fibre content.

REAGENTS

- Sulphuric acid solution 0.255 N, (12.5g, dilute to 1 litre)
- Sodium hydroxide solution, 0.312 N (12.5g carbonate free NaOH per litre)
- Asbestos-Gooch grade,
- Ethyl alcohol 95%
- Methylene Chloride, anhydrous
- Sample preparation: Sample is prepared as per ASTA method l

PROCEDURE

Extract 2 g of sample, taken in a thimble with methylene chloride to get the residue fat free. Transfer the residue to a digestion flask.

Add 200 ml of the sulphuric acid solution, connect the digestion flask to the condenser and place on a preheated hot plate adjusting so that the acid will boil in ca. 5 min. Continue boiling briskly for exactly 28 min with frequent rotation of the flask to ensure thorough wetting and mixing of the sample. Material should not be allowed to remain on the sides of the flask out of the contact with the solution. Successive sample digestions should be started at ca. 3 min intervals to facilitate accurate timing. After boiling for 28 minutes, remove the flask and filter immediately through a filter cloth in a funnel. Wash with boiling water until the washing is no longer acidic.

Transfer the sample quantitatively to the digestion flask, washing the filter cloth with 200 ml of the NaOH solution. Connect the flask to the reflux condenser, place on the preheated hot to boil in ca. 5 minutes, and boil for exactly 28 min. successive sample digestions should be started at ca. 3 min interval to facilitate accurate timing. After 28 min, remove the flask and immediately filter through a Gooch crucible. Wash the residue thoroughly with water and with ca. 15 ml of ethyl alcohol. Dry the crucible and the contents at 110 (+/-) 2 C to a constant weight (ca. one hour). Cool in a desiccator and weigh. Ignite the crucible and contents in an electric muffle furnace at ca. 600 deg. C for 20 minutes. Cool in a desiccator and weigh. Determine the loss in weight on ignition.

CALCULATION

$$\text{Crude fibre \%} = \frac{Loss\ in\ weight\ on\ ignition\ (g) \times 100}{Wt.of\ original\ sample\ (g)}$$

3.8.4 PROTEIN

The determination of protein content in cookies were done using AOAC method.

- Accurately weigh 0.70 to 2.20g of the sample into the digestion flask.
- Add 0.7g H2O and 15g Na2SO4.
- Add 25ml of Sulphuric acid.
- Place the flask in an inclined position on a heater and heat gently until frothing ceases
- Boil until clear.
- Cool and add about 200ml distilled water and cool to room temperature.
- Add 25ml Thiosulphate solution (8% in water) and mix to precipitate mercury.
- Add sodium hydroxide solution more carefully through the sides of the flask to make the solution strongly alkaline.
- Assemble the apparatus taking care that the tip of the condenser extends below the surface of a known quantity of standard sulphuric acid and add 5-7 drops of methyl red indicator
- Heat immediately until all ammonia has distilled (150ml)
- Lower the receiver before stopping distillation and wash the tip of the condenser with distilled water.
- Titrate against standard Sodium hydroxide solution
- Correct for blank determination on reagents.

CALCULATION:

$$\text{Nitrogen content (N) in \%} = \frac{[(Macid)(mlacid) - (mlNaOH)(MNaOH)] \times 1400.67}{mg\ test\ portion\ wt}$$

Where, Macid = molarity of standard acid,

mlacid = volume in ml of acid used as trapping solution

MNaOH = molarity of standard base

mlNaOH = volume in ml of standard base used for titrating

3.8.5 FAT

Transfer 5g of finely ground moisture free sample into an extraction thimble and plug the top with cotton. Place the thimble into the fat extraction tube of soxhlet apparatus. Attach the bottom of the extraction tube to a pre-weighed soxhlet flask. Pour approximately 75ml of anhydrous ether through the sample in the tube into the flask. Attach the top of fat extraction tube to the condenser. Extract the sample for 16hr on a heating mantle. Control the heating so that the ether which volatilizes condenses and drops continuously upon the sample without my appreciable loss. At the end of the extraction period, remove the soxhlet flask and evaporate the ether in the soxhlet flask on a steam bath at low heat. Then, dry at 100 ± 3°C for 1 hour, cool and weigh. The difference in the weights of the flask before and after extraction gives the ether soluble materials present in the sample.

CALCULATION

$$\text{Fat (g/100g)} = \frac{weight\ of\ ether\ soluble\ material\ in\ g \times 100}{Weight\ of\ sample\ in\ g}$$

3.8.6 CARBOHYDRATE

Determination of carbohydrate content in cookies were done using AOAC method.

Total carbohydrates are calculated as follows after determining the percentage of moisture, total protein, fat and total ash.

CALCULATION

Total Carbohydrates = 100 - (A+B+C+D)

Where, A = percent by mass of moisture

B = percent by mass of total protein

C = percent by mass of fat and

D = percent by mass of total ash

3.8.7 ENERGY

Calculate the energy value (total calories) per 100g of the food as follows:

Energy (kcal/100g) = 4 × C + 4 × P + 9 x F

Where, C = Carbohydrate content in g/100g

P=Protein content in g/100g

F=Fat content in g/100g

3.8.8 CALCIUM

APPARATUS:

- Porcelain dish
- Electric oven
- Weighing balance
- Volumetric flasks

PROCEDURE:

Weigh accurately about 2g of sample in a porcelain dish. Ignite in the furnace to carbon free ash, but avoid fusing. Boil the residue in 40 ml HCl (1+3) add a few drops of HNO3. Cool and transfer to a 250 ml standard flask, dilute to volume and mix. Pipette 25ml clear liquid into a beaker, dilute to 100ml and add 2 drops of methyl red. Add NH4OH (1+1) drop wise to pH 5.6 (brownish orange color). If overstepped add HCl (1+3) with dropper to orange Add two more drops of HCl to pink and pH 2.5-3.0. Dilute to 150ml and boil. Add slowly with constant stirring 10 ml of hot saturated (4.2%) solution of ammonium oxalate. If red changes to orange or yellow, add HCl drop wise until pink. Let stand overnight for precipitate to settle. Filter the supernatant through Whatman no.40 and wash the precipitate thoroughly with NH4OH (1+50). Place the paper in original beaker and add a mixture of 125ml water and 5 ml H2SO4. Heat to 70°C and titrate against 0.02MKMnO4 (0.IN) to slight pink colour.

3.8.9 IRON

REAGENTS

- o - Phenanthroline solution
- α, α - Dipyridyl solution
- Iron standard solution
- Hydroxylamine hydrochloride solution
- Magnesium nitrate solution
- Acetate buffer solution

PROCEDURE

By dry ashing:

Ash 5.00 g test portion in petri or porcelain dish. Cool and weigh if percent ash is desired. Continue ashing until practically C- free. To diminish ashing time, or products that do not burn practically C-free, use one of the following ash aids. Moisten ash with 0.5 1.0 ml $Mg(NO3)2$ solution or with redistilled $HNO3$. Dry and carefully ignite in furnace avoiding splattering (do not add these ash aids to self-rising flour and products containing NaCl) in Petri dish because of vigorous action on the dish. Cool, add 5 ml HCl, letting acid rinse the upper portion of the dish, and evaporate to dryness in a steam bath. Dissolve residue by adding 2.0 ml HCl, accurately measured and heat 5 min on steam bath with watch glass on dish. Rinse watch glass and dilute residue solution to 100ml with $H2O$. If necessary, filter diluted residue solution through ashless paper and discard first 15-20 ml filtrate. Pipette 10 ml aliquot into 25 ml volumetric flask and add 1ml $H2NOH$ HCl solution. Stand for 5 min. Add 5 ml Acetate buffer solution and 1ml o-Phenanthroline or 2 ml dipyridyl solution, and dilute to volume. Determine absorbance in spectrophotometer at ca 510 nm. From reading determine Fe concentration from equation of line representing standard points or by reference to standard curve for known Fe concentration. If further dilution required to maintain test solution absorbance reading below highest standard point on curve, pipet smaller Aliquot into 25.0 ml flask, ditute to 10 ml with 2% HCl solution and continue as described in above procedure. Determine blank on reagents and make corrections.
Calculate Fe in flour as mg/lb.

3.9 SHELF LIFE STUDY

Consumers are increasingly demanding high-quality food and expect that this quality is preserved from the moment of purchase until consumption. The shelf life refers to the period during which the food remains safe to eat. Various factors influence the shelf life of a product, including water activity, pH, oxygen levels, nutrients, natural microflora, and the use of preservatives. Additionally, factors like temperature and relative humidity also play a significant role. Shelf life is a critical aspect of the product that should be clearly stated on its label.

The cookies in question are made with Bajra flour, dried medicinal herbs powder and other ingredients. They are packaged in an airtight container, and stored in a cool, dark, and dry place. Two samples, the controlled S1 and S4, are kept at room temperature for storage. Each sample is labelled with the date of production and it is inspected weekly.

CHAPTER – 4

RESULT AND DISCUSSION

This chapter presents the findings and discussions derived from the observation conducted in the study titled "Development of Pearl millet cookies infused with Medicinal herbs". The primary aim of this study was to create a cookie that is enriched with nutritional value. Cookies were prepared in four different compositions. Sensory, nutritional and physical analysis were performed to assess the quality and nutritional content of the cookies. The results of these assessments are provided below.

4.1 SENSORY ANALYSIS

The sensory evaluations of cookies were carried out on a 5-point hedonic scale by 10 semi-trained panel members. From the sensory evaluation, Sample 4 (S4), which had 5% herbs, was found to be the best of all four samples.

Table 4.1: Average values of sensory evaluation

Sample	Appearance	Aroma	Taste	Texture	Overall Acceptability
S1	4	4	4.1	3.8	4.1
S2	3.7	4	3.6	4	3.8
S3	4.2	3.9	4.2	4	4.2
S4	4.4	4.2	4.2	4.6	4.5

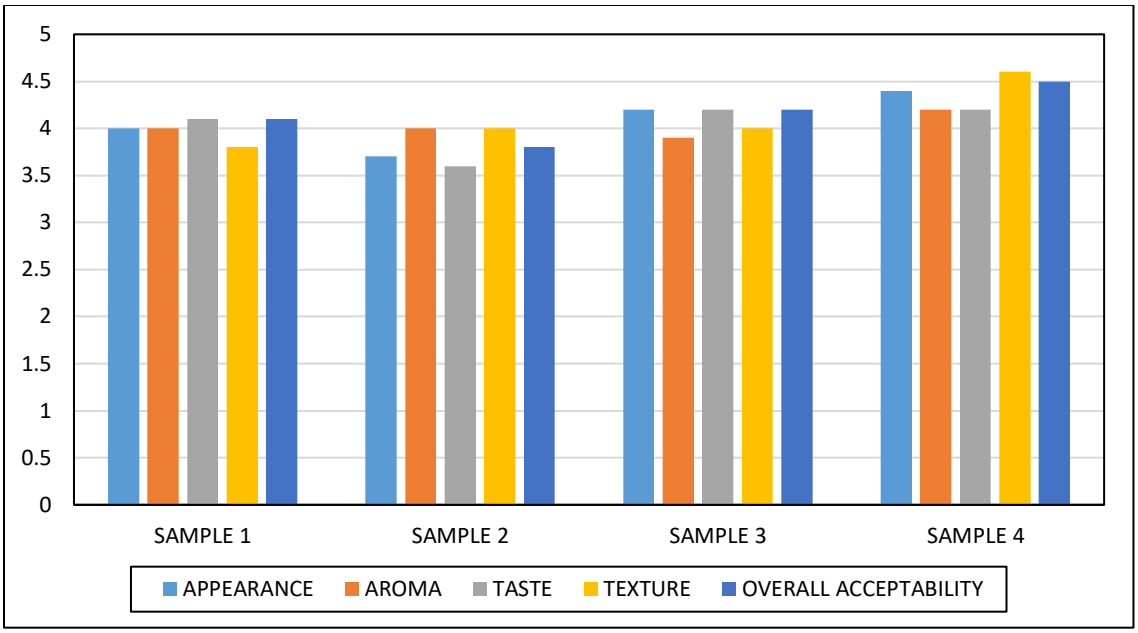

Fig 4.1: Sensory analysis

4.2 PROXIMATE ANALYSIS

Chemical analysis (carbohydrate, protein, fat, crude fiber, energy, calcium, iron, moisture content, ash) was conducted for nutritional comparative study of Sample 1 and Sample 4. The amount of Crude fiber, Fat, Energy and Calcium was significantly higher in Sample 4 compared to Sample 1. Proximate analysis of standard sample (Sample 1) and selected sample (Sample 4) is provided below:

Table 4.2: Proximate analysis

SL.NO	Parameters	Unit	Sample 1 (control)	Sample 4 (5% Herbs)
1	Moisture	%	11.96	5.82
2	Crude Fiber	%	0.28	4.77
3	Protein	%	6.73	5.80
4	Fat	%	12.46	14.04
5	Total Ash	%	1.93	2.22

6	Carbohydrate	g/100g	66.92	72.17
7	Energy	Kcal/100g	406.74	438.04
8	Calcium	mg/100g	338.36	377.78
9	Iron	mg/100g	9.56	4.17

4.3 PHYSICAL ANALYSIS

Physical analysis of samples was carried out and all of the results were nearly similar for characteristics such as Diameter, Thickness, Volume and Spread ratio. For the physical analysis Vernier Caliper was used.

Table 4.3: Physical Analysis

Samples	Diameter (mm)	Thickness (mm)	Volume (cm^3)	Spread ratio
S1	33.4	11.3	9.9	2.95
S2	35.3	11.2	10.96	3.15
S3	34.6	10.0	9.4	3.46
S4	36.1	9.2	9.42	3.92

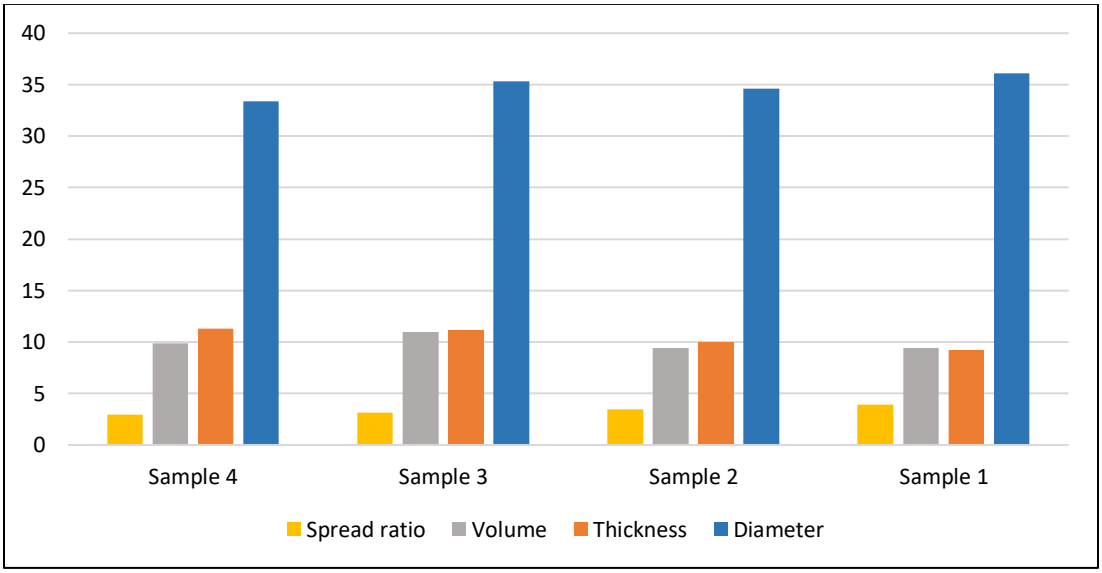

Fig 4.2: Physical analysis

4.4 SHELF LIFE ANALYSIS

Two samples Sample 1 (standard) and Sample 4 (5% herbs) were packed in airtight containers and were stored in room temperature in dark and dry place. Each sample is labelled with the date of production and it is inspected weekly. To date, regular inspections of the samples show no evidence of spoilage or mold growth, no visible changes in texture over a period of three weeks.

CHAPTER – 5

SUMMARY AND CONCLUSION

The research thesis described above focuses on Development of Pearl millet cookies infused with medicinal herbs. The study mainly aims at utilization and value addition of medicinal herbs in food products. To achieve this, the study employed a descriptive quantitative research methodology which involved preparing 4 varying ratios of ingredients: S1 (0% herbs), S2 (1.5% herbs), S3 (3% herbs), and S4 (5% herbs). The objective was to identify optimal concentration of ingredients that would enhance sensory attributes and overall acceptability.

The sensory evaluation was conducted using descriptive testing, where a panel of experts assessed the characteristics of the four formulations. The results demonstrated that the sample S4, containing 5% herbs, achieved the highest sensory acceptability rating and this sample was used in nutritional and physical analysis. Nutritional study concluded that the cookie was highly nutritious by assessing parameters like energy, fiber, calcium, iron, carbohydrate, fat and protein.

Overall analysis indicated that cookies with acceptable physical characteristics and improved nutritional profile was produced with complete replacement of Maida, thereby adding health benefits and nutritional value to baked products and also contributing to reduction of obesity. More and more value added products can be made from such type of underutilized herbs like Indian borage and Tulsi. Better technologies can also be added to enhance the storage, processing, preservation of these cookies in the food industries.

In conclusion, the research provides valuable insights into the potential of using medicinal herbs and Bajra flour in the food processing sector, specifically in the development of a nutritionally improved millet-herb cookie. The optimal concentration of herbs powder has been identified, which can serve as a foundation for further research and development in this area. The findings of this study may encourage the food industry to explore alternative ingredients and formulations, ultimately contributing to more diverse and nutritious food products.

CHAPTER – 6

REFERENCES

1. Alam, M., Alam, M., Hakim, M., Huq, A. O., & Moktadir, S. G. (2014). Development of fiber enriched herbal biscuits: a preliminary study on sensory evaluation and chemical composition. Int J Nutr Food Sci, 3, 246-250.
2. Saleh, A. S., Zhang, Q., Chen, J., & Shen, Q. (2013). Millet grains: nutritional quality, processing, and potential health benefits. *Comprehensive reviews in food science and food safety*, *12*(3), 281-295.
3. Yousaf, L., Hou, D., Liaqat, H., & Shen, Q. (2021). Millet: A review of its nutritional and functional changes during processing. Food Research International, 142, 110197.
4. Hassan, Z. M., Sebola, N. A., & Mabelebele, M. (2021). *The nutritional use of millet grain for food and feed: a review. Agric Food Secur 10: 16*.
5. Kumar, A., Tripathi, M. K., Joshi, D., & Kumar, V. (Eds.). (2021). *Millets and millet technology* (p. 438). Singapore: Springer.
6. Baryeh, E. A. (2002). Physical properties of millet. *Journal of food engineering*, *51*(1), 39-46.
7. Hussain, S. A., Panjagari, N. R., Singh, R. R. B., & Patil, G. R. (2015). Potential herbs and herbal nutraceuticals: food applications and their interactions with food components. *Critical Reviews in Food Science and Nutrition*, *55*(1), 94-122.
8. Dias, N. A. I. S., & Bandara, G. M. W. R. (2019). Nutritive assessment of composite flour biscuit incorporated with herbal plant powder. *Journal of Food and Agriculture*, *12*(1).
9. Pestorić, M., Šimurina, O., Filipčev, B., Jambrec, D., Belović, M., Mišan, A., & Nedeljković, N. (2015). Relationship of physicochemical characteristics with sensory profile of cookies enriched with medicinal herbs. *International Journal of Food Properties*, *18*(12), 2699-2712.
10. Čukelj, N., Novotni, D., Sarajlija, H., Drakula, S., Voučko, B., & Ćurić, D. (2017). Flaxseed and multigrain mixtures in the development of functional biscuits. *LWT*, *86*, 85-92.
11. Haque, M. A., Mandal, R., Akter, N., Akter, S., & Sultana, M. M. (2016). A Study on Development and Evaluation of Functional Herbal Wafer Biscuits. *Journal of Environmental Science and Natural Resources*, *9*(1), 17-21.
12. Kozlowska, M., Zbikowska, A., Marciniak-Lukasiak, K., & Kowalska, M. (2019). Herbal extracts incorporated into shortbread cookies: Impact on color and fat quality of the cookies. *Biomolecules*, *9*(12), 858.
13. Slama, A., Cherif, A., Sakouhi, F., Boukhchina, S., & Radhouane, L. (2020). Fatty acids, phytochemical composition and antioxidant potential of pearl millet oil. *Journal of Consumer Protection and Food Safety*, *15*, 145-151.
14. Nambiar, V. S., Dhaduk, J. J., Sareen, N., Shahu, T., & Desai, R. (2011). Potential functional implications of pearl millet (Pennisetum glaucum) in health and disease. *Journal of Applied Pharmaceutical Science*, (Issue), 62-67.
15. Yadav, O. P., & Rai, K. N. (2013). Genetic improvement of pearl millet in India. *Agricultural*

Research, *2*, 275-292.
16. Malik, S. (2015). Pearl millet-nutritional value and medicinal uses. *International Journal of Advance Research and Innovative Ideas in Education*, *1*(3), 414-418.
17. Pattanashetti, S. K., Upadhyaya, H. D., Dwivedi, S. L., Vetriventhan, M., & Reddy, K. N. (2016). Pearl millet. In *Genetic and genomic resources for grain cereals improvement* (pp. 253-289). Academic Press.
18. Jain, R. K., & Bal, S. (1997). Properties of pearl millet. *Journal of agricultural engineering research*, *66*(2), 85-91.
19. Juntachote, T., & Berghofer, E. J. F. C. (2005). Antioxidative properties and stability of ethanolic extracts of Holy basil and Galangal. *Food chemistry*, *92*(2), 193-202.
20. Thakur, A., & Thapa, D. (2023). Holy Basil (Ocimum sanctum): A comprehensive review of traditional uses, phytochemical composition, medicinal properties and future directions. *Just Agric*, *3*, 136-151.
21. Baliga, M. S., Jimmy, R., Thilakchand, K. R., Sunitha, V., Bhat, N. R., Saldanha, E., ... & Palatty, P. L. (2013). Ocimum sanctum L (Holy Basil or Tulsi) and its phytochemicals in the prevention and treatment of cancer. *Nutrition and cancer*, *65*(sup1), 26-35.
22. Singh, D., & Chaudhuri, P. K. (2018). A review on phytochemical and pharmacological properties of Holy basil (Ocimum sanctum L.). *Industrial Crops and Products*, *118*, 367-382.
23. Jamshidi, N., & Cohen, M. M. (2017). The clinical efficacy and safety of Tulsi in humans: a systematic review of the literature. *Evidence-Based Complementary and Alternative Medicine*, *2017*(1), 9217567.
24. Dwivedy, S., Rayaguru, K., & Sahoo, G. R. (2012). Effect of drying methods on quality characteristics of medicinal Indian borage (Coleus aromaticus) leaves. *J Food Process Technol*, *3*(11), 1-6.
25. Prasad, N., Basalingappa, K. M., Gopenath, T. S., Razvi, S. M., Murugesan, K., Ashok, G., & Divyashree, K. C. (2020). Nutritional significance of Indian borage (Plectranthus amboinicus): a review.
26. Bhatt, P., Joseph, G. S., Negi, P. S., & Varadaraj, M. C. (2013). Chemical composition and nutraceutical potential of Indian borage (Plectranthus amboinicus) stem extract. *Journal of Chemistry*, *2013*(1), 320329.
27. Satheesh, V., Kaur, J., Jarial, S., Ghosh, P., Sharma, K., Patni, M., ... & Bhadariya, V. (2022). Indian borage: A comprehensive review on the nutritional profile and diverse pharmacological significance. *The Pharma Innovation Journal*, *11*(6), 42-51.
28. KC, Y., Bhattarai, S., Shiwakoti, L. D., Paudel, S., Subedi, M., Pant, B. R., ... & Upadhyaya, J. (2022). Sensorial and chemical analysis of biscuits prepared by incorporating Moringa flower powder and leaf powder. International journal of food properties, 25(1), 894-906.
29. Aljobair, M. O. (2022). Physicochemical, nutritional, and sensory quality and storage stability of cookies: effect of clove powder. International Journal of Food Properties, 25(1), 1009-1020.
30. Haque, M. A., Mandal, R., Akter, N., Akter, S., & Sultana, M. M. (2016). A Study on Development and Evaluation of Functional Herbal Wafer Biscuits. Journal of Environmental

Science and Natural Resources, 9(1), 17-21.
31. Kozlowska, M., Zbikowska, A., Marciniak-Lukasiak, K., & Kowalska, M. (2019). Herbal extracts incorporated into shortbread cookies: Impact on color and fat quality of the cookies. Biomolecules, 9(12), 858.
32. Dias, N. A. I. S., & Bandara, G. M. W. R. (2019). Nutritive assessment of composite flour biscuit incorporated with herbal plant powder. Journal of Food and Agriculture, 12(1).
33. Pestorić, M., Šimurina, O., Filipčev, B., Jambrec, D., Belović, M., Mišan, A., & Nedeljković, N. (2015). Relationship of physicochemical characteristics with sensory profile of cookies enriched with medicinal herbs. International Journal of Food Properties, 18(12), 2699-2712.
34. Pareyt, B., & Delcour, J. A. (2008). The role of wheat flour constituents, sugar, and fat in low moisture cereal based products: a review on sugar-snap cookies. Critical reviews in food science and nutrition, 48(9), 824-839.
35. Pestorić, M., Škrobot, D., Žigon, U., Šimurina, O., Filipčev, B., Belović, M., & Mišan, A. (2017). Sensory profile and preference mapping of cookies enriched with medicinal herbs. International Journal of Food Properties, 20(2), 350-361.
36. Dzandu, B., Kumi, S., & Asirifi-Addo, T. (2023). Quality assessment of gluten-free cookies from rice and Bambara groundnut flour. CyTA-Journal of Food, 21(1), 258-268.
37. Vitali, D., Dragojević, I. V., & Šebečić, B. (2009). Effects of incorporation of integral raw materials and dietary fibre on the selected nutritional and functional properties of biscuits. Food chemistry, 114(4), 1462-1469.
38. Waleed, A. A., Mahdi, A. A., Li, Y., Qian, H., & Wang, L. (2018). Optimization and acceptability evaluation of shapporah biscuits formulated by different ingredients: using response surface methodology (RSM). Journal of Food and Nutrition Research, 6(3), 192-199.
39. Jamale, S., Sahoo, A., Patil, S., & Jamdar, J. (2022). Formulation of ragi and whole wheat flour supplemented Nutri cookies.
40. Misra, N. N., & Tiwari, B. K. (2014). Biscuits. Bakery products science and technology, 585-601.
41. Mihafu, F. D., Issa, J. Y., & Kamiyango, M. W. (2020). Implication of sensory evaluation and quality assessment in food product development: A review. Current Research in Nutrition and Food Science Journal, 8(3), 690-702.
42. Kemp, S. E. (2008). Application of sensory evaluation in food research. International Journal of Food Science and Technology, 43(9), 1507-1511.
43. Ganorkar, P. M., & Jain, R. K. (2014). Effect of flaxseed incorporation on physical, sensorial, textural and chemical attributes of cookies. International Food Research Journal, 21(4).
44. Nazim, H. A. A., & Othman, A. (2025). Characterization of meringue formulated with different palm sugar substitutes. Food Research, 9(1), 272-281.
45. Hegde, A. S., Gupta, S., Sharma, S., Srivatsan, V., & Kumari, P. (2022). Edible rose flowers: A doorway to gastronomic and nutraceutical research. Food Research International, 162, 111977.

APPENDIX

SCORE CARD

HEDONIC RATING SCALE

Name:

Product: Bajra cookie infused with medicinal herbs

Date:

Four samples are provided. Taste the sample and check how much you like or dislike each of the characteristics.

	Appearance	Aroma	Taste	Texture	Overall acceptability
SAMPLE 1					
SAMPLE 2					
SAMPLE 3					
SAMPLE 4					

5-Point Hedonic scale

5	Like a lot
4	Like a little
3	Neither like nor dislike
2	Dislike a little
1	Dislike a lot

Comments: Signature:

SCORE CARD

HEDONIC RATING SCALE

Name: Marwa Nasir

Product: Bajra cookie infused with medicinal herbs

Date: 14/8/25

Four samples are provided. Taste the sample and check how much you like or dislike each of the characteristics.

	Appearance	Aroma	Taste	Texture	Overall acceptability
SAMPLE 1	5	5	4	5	4
SAMPLE 2	3	4	4	4	3
SAMPLE 3	5	5	4	4	4
SAMPLE 4	5	5	4	5	5

5-Point Hedonic scale

5	Like a lot
4	Like a little
3	Neither like nor dislike
2	Dislike a little
1	Dislike a lot

Comments: Sample A is more preferable.

Signature: Marwa

SCORE CARD

HEDONIC RATING SCALE

Name: Aishwarya Sreelakshmi. S

Product: Bajra cookie infused with medicinal herbs

Date: 14/3/25

Four samples are provided. Taste the sample and check how much you like or dislike each of the characteristics.

	Appearance	Aroma	Taste	Texture	Overall acceptability
SAMPLE 1	3	2	4	3	4
SAMPLE 2	2	4	3	3	3
SAMPLE 3	4	3	4	4	4
SAMPLE 4	4	4	5	5	5

5-Point Hedonic scale

5	Like a lot
4	Like a little
3	Neither like nor dislike
2	Dislike a little
1	Dislike a lot

Comments: Sample 4 is good as it is similar to other cookies.

Signature:

SCORE CARD

HEDONIC RATING SCALE

Name: Mahima V.K

Product: Bajra cookie infused with medicinal herbs

Date: 14 | 8 | 2025

Four samples are provided. Taste the sample and check how much you like or dislike each of the characteristics.

	Appearance	Aroma	Taste	Texture	Overall acceptability
SAMPLE 1	3	5	5	4	5
SAMPLE 2	4	5	4	5	4
SAMPLE 3	5	4	5	3	4
SAMPLE 4	5	4	4	5	5

5-Point Hedonic scale

5	Like a lot
4	Like a little
3	Neither like nor dislike
2	Dislike a little
1	Dislike a lot

Comments: Sample 4 is very good

Signature: Mahima

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TEST REPORT

Test report No.: **MB/LT/2025-26/0011/C2**

Customer Name & Address: **ST. TERESA'S COLLEGE** **PARK AVE, MARINE DRIVE,** **EKM, KERALA,** **622011** **PH: 7907074848**	Ref No./PO No. :MBL/25/0338 Date of Receipt :21/03/2025 Date of Analysis :22/03/2025 Date of Completion :03/04/2025 Date of Issue report :04/04/2025

Sample Name :Cookies-Control
Sample Description :Brown Colour circular Cookies
Batch no :NA
Sampled By :Customer
Sample Ref. No. :MBL/25/0338
Sample Condition on Receipt: Good

TEST RESULTS

Sl.No.	Parameters	Test method	Unit	Result
1.	Protein	In House Method	%	6.73
2.	Fat	In House Method	%	12.46
3.	Total Ash	In House Method	%	1.93
4.	Carbohydrate	In House Method	g/100g	66.92
5.	Energy	In House Method	Kcal/100g	406.74
6.	Calcium	In House Method	mg/100g	338.36
7.	Iron	In House Method	mg/100g	9.56

End of Report

Suchithra Bhat
Authorized Signatory (Chemistry)
Pg.1/1

NOTE: This test result relate only to the sample submitted for analysis. Queries shall be made within 7 days of issue of this report. This test report shall not be reproduced except in full without the written approval of the laboratory. Samples shall not be stored beyond 7 days

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TC-15392

TEST REPORT

Test report No.: **MB/LT/2025-26/0011/C1**	
Customer Name & Address: **ST. TERESA'S COLLEGE** **PARK AVE, MARINE DRIVE,** **EKM, KERALA,** **622011** **PH: 7907074848**	Ref No./PO No. :MBL/25/0338 Date of Receipt :21/03/2025 Date of Analysis :22/03/2025 Date of Completion :03/04/2025 Date of Issue report :04/04/2025
Sample Name :Cookies-Control Sample Description :Brown Colour circular Cookies Batch no :NA Sampled By :Customer Sample Ref. No. :MBL/25/0338 Sample Condition on Receipt: Good	**ULR-TC1539225100000271F** **DISCIPLINE :CHEMISTRY** **GROUP: Food & Agricultural Products**

TEST RESULT

Sl.No.	Parameters	Test method	Unit	Result
1.	Moisture	IS 1483	%	11.96
2.	Crude Fiber	IS 1483	%	0.28

End of Report

PVT MERIT BIOLABS KOCHI

Suchithra Bhat
Authorized Signatory (Chemistry)
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NOTE: This test result relate only to the sample submitted for analysis. Queries shall be made within 7 days of issue of this report. This test report shall not be reproduced except in full without the written approval of the laboratory. Samples shall not be stored beyond 7 days

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TEST REPORT

Test report No.: **MB/LT/2024-25/0012/C1**			
Customer Name & Address: **ST. TERESA'S COLLEGE** **PARK AVE, MARINE DRIVE,** **EKM, KERALA,** **622011** **PH: 7907074848**		Ref No./PO No. Date of Receipt Date of Analysis Date of Completion Date of Issue report	:MBL/25/0339 :21/03/2025 :22/03/2025 :03/04/2025 :04/04/2025
Sample Name Sample Description Batch no Sampled By Sample Ref. No. Sample Condition on Receipt: Good	:Cookies-Varient :Brown colour circular Cookies :NA :Customer :MBL/25/0339		

TEST RESULTS

Sl.No.	Parameters	Test method	Unit	Result
1.	Protein	In House Method	%	5.80
2.	Fat	In House Method	%	14.04
3.	Total Ash	In House Method	%	2.22
4.	Carbohydrate	In House Method	g/100g	72.12
5.	Energy	In House Method	Kcal/100g	438.04
6.	Calcium	In House Method	mg/100g	377.78
7.	Iron	In House Method	mg/100g	4.17

End of Report

Suchithra Bhat
Authorized Signatory (Chemistry)
Pg.1/1

NOTE: This test result relate only to the sample submitted for analysis. Queries shall be made within 7 days of issue of this report. This test report shall not be reproduced except in full without the written approval of the laboratory. Samples shall not be stored beyond 7 days

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TC-15392

TEST REPORT

Test report No.: **MBLT/2024-25/0012/C1**	
Customer Name & Address: **ST. TERESA'S COLLEGE** **PARK AVE, MARINE DRIVE,** **EKM, KERALA,** **622011** **PH: 7907074848**	Ref No./PO No. :MBL/25/0339 Date of Receipt :21/03/2025 Date of Analysis :22/03/2025 Date of Completion :03/04/2025 Date of Issue report :04/04/2025
Sample Name :Cookies-Varient Sample Description :Brown colour circular Cookies Batch no :NA Sampled By :Customer Sample Ref. No. :MBL/25/0339 Sample Condition on Receipt: Good	**ULR-TC1539225100000272F** **DISCIPLINE :CHEMISTRY** **GROUP: Food & Agricultural Products**

TEST RESULT

Sl.No.	Parameters	Test method	Unit	Result
1.	Moisture	IS 1483	%	5.82
2.	Crude Fiber	IS 1483	%	4.77

End of Report

Suchithra Bhat
Authorized Signatory (Chemistry)
Pg.1/1

NOTE: This test result relate only to the sample submitted for analysis. Queries shall be made within 7 days of issue of this report. This test report shall not be reproduced except in full without the written approval of the laboratory. Samples shall not be stored beyond 7 days