

## Development of Multigrain Cookies

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### ABSTRACT

*Baking Industry is considered as one of the major segments of food processing in India. Bakery products have become popular among different cross sections of the population due to an increased demand for convenience foods. Cookies, among the bakery products, are most significant in the world. These are an important food product used as snacks by children and adults. Cookies differ from other baked products like bread and cakes due to their low moisture content which ensures that they are free from microbial spoilage and confer a long shelf life on the product. The present study is an attempt to formulate higher nutritional value of cookies with added health benefit by addition of whole wheat flour, finger millet flour and oats flour along with the addition of chia seeds. Sugar is replaced by jaggery power. In the present study, C1, C2, C3 and C4 were formulated in which multigrain cookies were prepared by using whole wheat flour: Finger millet flour: Oats flour (WWF: FMF: OF) in the ratio of (40:15:15, 15:40:15, 15:15:40, 23.3:23.3:23.3) respectively. Among all the formulations C2 and C4 were mostly liked by all the panelists. Proximate analysis was carried out for the four formulations, where the moisture content ranges between 3.3 to 3.7%, total ash ranges between 0.86-0.95%, acid insoluble ash ranges between 0.07 -0.09%, fat content ranges between 7.2-9.3%, acidity of extracted fat ranges between 0.9-1.22%, protein ranges between 11.5-13.8% and carbohydrate ranges between 67- 78.4%. The shelf-life studies revealed that the cookies can be stored for 30 days and can be eaten.*

**Key words:** *Multigrain cookies; Chia seeds and Health benefits of multigrain cookies*

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Date of Submission: 20-09-2022

Date of acceptance: 04-10-2022

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### I. INTRODUCTION

Advancement of innovative features in product is the new tactical part of the food industry. Nowadays, due to hectic life, people have been demanding ready-to-cook foods that are easy to prepare, consumes less time in cooking, are healthy, have a good shelf life, and have a delicious taste. So, in this study, all these attractive features are tried to include into the cookie. Cookies are processed food that all age group of people highly eat as a snack. Its production is more and available worldwide. In these days customers are expecting, foods that show two main vital properties: first-one deals with the traditional nutritional features of the food, as well as, a second feature, supplementary health benefits are predictable from its regular ingestion. Foods which are having high nutrition have expanded incredible attention worldwide over the earlier few years due to healthy lifestyle fluctuations. One of the encouraging reasons to move to a healthier lifestyle is the growing number of people suffering from high blood pressure, cardiovascular diseases (CVDs), diabetes, obesity, and other related diseases. These conditions are generally due to lazy lifestyle and poor diet where the regular food consumed holds more quantities of saturated fatty acids (SFAs). The total dietary fiber (TDF) has become a noteworthy element in the daily diet because intake of total dietary fiber has health advantageous effects. One of the foremost tasks in baking trade is the production of gluten-free products. Cookies are extensively familiar and consumed in developing countries. Traditionally cookies are made out of wheat flour. The name "Cookie" originates from the Dutch word 'Koekie' or 'Koekie' that means little cake. Cookies, like cakes, are chemically leavened with baking powder and baking soda. Cookies, however, contain more sugar and shortening agent and less water proportionately. In this study, we tried to assess the suitability of replacement of "Maida" by using other flours[9]

Nutritional enhancement is one of existing attention since it is a consumer trend, government guiding principle and altering demographics. These aspects are instigating the industry to be alert of the necessity for nutritional food products. Protein substitution is one of the ways to lighten the necessity for nutritious foods, predominantly baked products. The nutritional implication of the bakery products is well known. Efforts are being made to boost the products with fine quality non-wheat flours. Bakery products can oblige as a virtuous vehicle for carrying the added proteins to marked populations for use in fighting the protein malnourishment dominant in innumerable parts of the World. Cookies are generally flat, small, and round. It is available in several flavours. The main ingredients are flour, fat, sugar, salt, and water, depending on the type[10]

In this study the cookies were prepared where refined wheat flour is replaced by whole wheat flour, finger millet flour and oats flour.

### **1.1 Whole wheat**

Wheat is the greatest amount of cereal accessible all around the world and it has gained much more popularity in recent years due to its plentiful health advantage. Wheat is a colossal energy source through all pieces of the grain bit, including the bran, kernel, and endosperm. Wheat is the significant grain generally utilized for making bread than some other cereal. The protein assembled gluten makes bread mixture stick and empowers it to hold gas. Wheat gives around 20% of the food calories for the world's people and is a public staple in numerous nations. Wheat is the principal fixing in most crackers, breads, rolls, biscuits, cakes, cookies, macaroni, puddings, doughnuts, pizza, spaghetti and many arranged hot and cold breakfast food varieties. Wheat is plentiful in reactant components, zinc, mineral salts, magnesium, chlorine, iodide, potassium, sulphur, vitamin B, arsenic, silicon, manganese, copper, calcium and vitamin E. Wheat is the chief contributor of protein content of regular diet. This abundance of supplements is the reason it is habitually utilized as a cultural base or root of nutrition. Issues like gallstones, breast feeding problems, tuberculosis, mineral deficiencies, breast cancer, obesity, chronic inflammation, pregnancy, anaemia and asthenia, quickly worked on by consuming entire wheat. Plentiful of the wheat utilized for domesticated animals and poultry feed is a side-effect of the flour processing industry. The supplements are in it remained even after making it into flour. Wheat flour is a powder produced by grinding the wheat used for human feeding. Wheat variabilities are called are called soft, in the event that gluten content is low and are called hard assuming they have high gluten content. Hard flour, or bread flour, is more in gluten, with 12% to 14% gluten content, and mixture has elastic toughness that holds its shape well once baked. Soft flour is nearly less in gluten and consequently brings about a portion with a better, brittle surface. As human population kept on expanding, there is a significant overall interest in the use of wheat-based food items [8]

### **1.2 Oats**

Oats (*Avena Sativa* L.) are good source of fiber, proteins and minerals. The quantity of oats used for human feeding has enlarged gradually, the fact that the health properties of oats benefit mostly on the B-glucan content and total dietary fiber. The germ of oats and bran also cover phytochemicals including tocotrienols, phenolic compounds, tocopherols and plant sterols, supposed to have an advantageous outcome on health. Usually, oats have been proficient as a feedstuff grain of minute value. In Polish practice flaked oat grains are consumed as a part of healing weight control plans and tracked down rather in the menu of needy individuals. Oats are rich in dietary fiber but more prominently, oats are rich in fiber, explicitly,  $\beta$ -glucan, which diminishes blood cholesterol level by expanding the discharge of bile in the body. Oats can be measured as a high calorie food comprising 19% higher number of calories than wheat. Oats are also rich in the B vitamins, contain the anti-oxidant, vitamin E and oats are plentiful in minerals also. Oatmeal is stimulant for treats anorexia, general debility is good for recovery and fatigue, helps to control hormonal activity and lowers blood cholesterol levels. Oatmeal diminishes the gamble of strokes and respiratory failures from impeded supply routes, settles glucose and expands the body's capacity to fight off irresistible illness. [9]

### **1.3 Finger millet**

Finger millet [*Eleusine coracana* (L.)] normally called as ragi is vital minor millet broadly grown in Asia and Africa. It is formerly native to the Ethiopian highlands and was familiarised in India a very long time ago. Karnataka has the abundant part under finger millet and is the principal producer of ragi in India. Ragi is the central staple food ate by most of the population in South Karnataka. Millets are chiefly rich in minerals like magnesium, potassium, phosphorous and iron. Finger millet (Ragi) is the richest in calcium content, multiple times that of wheat or paddy rice. Calcium and iron are vital minerals expected by a human body to appropriately work. Lack of calcium can lead to osteoporosis, increase the risk of fractures, cramping of muscles and osteopenia. Lack of iron generally leads in anaemia. Ragi the centre of wellbeing assists in losing weight. It diminishes cholesterol content of the body and returns skin maturing. It improves bone strength and go about as a characteristic treatment for different illnesses like osteoporosis, diabetes, brittle bones and anaemia. It has remarkable healthy benefit and is even better than other normal cereals. Despite of finger millet's rich supplement profile, late examinations shows that lower utilization of millets in everyday by metropolitan Indians. Finger millet is processed by malting, fermentation, milling, decortication and popping. Vermicelli, noodles, pasta, Indian sweet (halwa) mixes, papads, soups and bakery products from finger millet are also emerging [9]

### **1.4 Chia seeds**

The health advantages of chia seeds are not precisely new as a matter of fact; individuals have been consuming them for over 5,000 years. Chia seeds are initially from Mexico and Guatemala, chia i.e., *Salvia*

hispanica L., an individual from the mint family was involved by the Aztecs and Mayans in everything from dinners to drugs to beauty care products. Chia seeds are wealthy in fiber, which helps with satiety, the sensation of fullness. A 25grams of chia seeds contains roughly 9grams of fiber. The day to day suggested measure of fiber is 30grams, so counting a 25grams of chia seeds, every day could be a beneficial contribution. Fiber is significant for a well digestive system and most of the population do not even reach the recommended target [9]

### 1.5 Health benefits of Multigrain Cookies

**Reduce constipation symptoms:** Major health benefits of multigrain cookies is that they contain fiber nutrients. But regular cookies do not contain any fiber nutrients because of the refining process they have gone through. Multigrain cookies are not artificially processed, includes all the whole grains, including fiber-rich ingredients. Because of the fiber ingredients, multigrain cookies help to diminish various major health issues like diabetes, cardiovascular diseases, and constipation issues. It also improves digestive system.

**Boost your daily energy levels:** Multigrain cookies includes various vitamins, mostly B-vitamins. As per medical research, B-vitamins are the energy source in human bodies so that anyone can be more energized throughout their workdays. Also, Vitamin B3 aids to nourish our skin health and gives us the energy to keep us going throughout the whole day. The vitamins present in multigrain cookies aid to nourish our nervous system and regulate our appetite. Even vitamin B6 works as a healthy nutrient in human body and produces healthy red cells. That can aid fight serious health problems and decrease the risk of viral infections in our bodies.

**It produces healthy red cells:** Multigrain cookies are enhanced with iron and other nutrients. Consuming iron on regular basis helps in producing functional red blood cells in human bodies. So, the red cells can depend on oxygen transport in the body. Iron benefits muscle cells to stock oxygen for future use. That participate in an important part in the energy construction of DNA synthesis, which is the power source of human cell growth [12]

## II. REVIEW OF LITERATURE

### Ingredients used for the cookies:

Cookies are popular among all age groups because of its affordable price, convenience, shelf life and nutritive value. Most of the cookies used refined flour as a common flour because of its elastic property. It gives the assembly in baked products. Refined wheat flour has proteins that interrelates with one another when they mixed with water, creating gluten. Gluten is flexible in property which elasticities to cover the expanding leavening gases during rising. So, refined wheat flour is used as a base flour for all the cookies. In addition to refined wheat flour other flours were also used in some of the research papers to enhance the nutrient contents of the cookies such as little millet flour, red rice flour, foxtail millet flour, fenugreek flour, oats flour, defatted soy flour, soyabean flour, moth bean flour and chick pea flour. In most of the papers, for the preparation of cookies the sweetening agent used was sugar. In paper [6], stevia leaves powder was used. In paper [5], icing sugar was used. Fat is important in making of cookies. It acts as shortening agent. It lubricates dough, more importantly it helps to retain the gases released during baking thus making sure that it is well risen loaf which will have a soft crumb. Different types of fats used in different paper such as vegetable oil, butter, ghee, vanaspati and margarine. Other than flour, fat and sweetening agent, other ingredients are also important in preparation of cookies. Other ingredients used in making of cookies are egg, milk powder, salt, baking powder leavening agents such as sodium bicarbonate and ammonium bicarbonate, flavours used are vanilla extract, vanilla essence, coffee and custard powder. These cookies were baked at different temperatures at a different period of time. Most commonly used baking time and temperature was 150°C for 20 minutes.

**Table 2.1: Ingredients used for the cookies**

SL NO.	Name of the cookie	Flour	Fat	Sweetening agent	Others	Baking time and Temp	Reference
1	Little millet cookies	Refined wheat flour and little millet flour	Vegetable oil	sugar	Sodium bicarbonate, ammonium bicarbonate	180°C for 12 mins	Biradar <i>et al.</i> , 2020. [1]
2	Red rice cookies	Refined wheat flour, red rice flour	Butter	Sugar	Vanilla essence, egg and baking powder	150°C for 30 mins	Gebi and Birinchi, 2020. [2]
3	Foxtail millet cookies	Wheat flour and foxtail millet flour	Margarine	Sugar	Vanilla and baking powder	165°C for 15 mins	Sambavi, <i>et al.</i> , 2015. [3]
4	Wheat based cookies enriched with fenugreek and oat flours	Wheat flour, oats flour and fenugreek flour	Sunflower oil	Sugar	Vanilla extract, baking powder and salt	200°C for 10 mins	Abiyot, <i>et al.</i> , 2020. [4]

5	Cookies enriched with mint leaf powder	Wheat flour and mint powder	Ghee	Icing sugar	Egg, milk powder, coffee, salt and baking powder	170°C for 15 mins	Arafat, <i>et al.</i> , 2021. [5]
6	Protein rich and less-calorie cookies	Defatted soy flour and refined wheat flour	Vanaspati	Stevia leaves powder	Vanilla essence, ammonium bicarbonate and ammonium bicarbonate	150°C for 20 mins	Amith, <i>et al.</i> , 2011. [6]
7	High protein cookies	Refined wheat flour, soybean flour, moth bean flour and chickpea flour	Vegetable oil	Sugar	Custard powder as flavouring agent and leavening agents	160°C for 15 mins	Nihir, <i>et al.</i> , 2018. [7]
8	High nutrient cookies	Refined wheat flour, flax seed flour and poppy seed flour	Margarine	Sugar	Skimmed milk powder, lemon grass powder, sodium bicarbonate, ammonium bicarbonate and tertiary butyl hydroquinone	160°C for 15 mins	Deepali, <i>et al.</i> , 2015. [8]
9	Cookies incorporated with pumpkin seeds	Wheat flour and pumpkin seed powder	Butter	Sugar	Fresh milk, baker's yeast and sodium bicarbonate	120°C for 20 mins	Garsa, 2020. [41]
10	Cookies incorporate with pumpkin seeds	Refined wheat flour and pumpkin seeds powder	Butter	Sugar	Milk and baking powder	180-220°C for 15-20 mins	Manpreet <i>et al.</i> , 2017. [40]
11	Cookies incorporate with Pomegranate seed	Refined wheat flour, defatted soybean flour and pomegranate seed powder	Vanaspati	Sugar	Skimmed milk powder and baking powder	120°C for 20 mins	Harish <i>et al.</i> , 2022. [42]
12	High protein and dietary fiber cookies	Wheat flour, sorghum, barley, defatted soya flour and chickpea	Vegetable oil	Sugar	Skimmed milk powder, dextrose, salt and vanilla essence	200°C for 10 mins	Ashwath <i>et al.</i> , 2015. [44]

### Ingredients used for Multigrain cookies:

Multigrain cookies are rich in fibres. Usually, cookies are made with refined wheat flour that have less fibre because the refining procedure eliminates the portion of the grain that include fiber, departing just the starchy endosperm. Multigrain cookies are made with entire grains and it comprise all the three regions of the grain, as well as the fibre enriched bran. There are different kinds of multigrain available. In most of the research papers, they have used rolled oats flour, barley flour, whole wheat flour, maize flour, sweet potato flour, pearl millet flour, finger millet flour chickpea flour, buckwheat flour and water chestnut flour. Sugar is used as sweetening agent in all the papers. In paper [17], they have used honey as a sweetening agent. Fat is the main ingredient in making cookies because it acts as shortening agent. Different fats are used in the papers. Mostly, vegetable oil is used in most of the papers. In some of the papers they have used margarine, ghee and butter. Other ingredients used are sodium bicarbonate, ammonium bicarbonate, skimmed milk powder, baking powder or baking soda, vanilla essence, salt, milk powder, egg, and peanut butter. The baking time and the baking temperature is different for each of the cookies depending upon the multigrain they have used.

**Table 2.2: Multigrain cookies ingredients**

SL NO.	Name of the cookie	Multigrain used	Fat	Sweetening agent	Others	Baking time & Temp.	Reference
1	Multigrain cookie	Green gram flour, oats flour and whole wheat flour	Butter	Sugar	Skimmed milk powder and baking powder	160°C for 20-25mins	Veer, <i>et al.</i> , 2018. [9]
2	Functional multigrain cookie	Buckwheat flour, chickpea flour, water chestnut flour and chia seeds	Butter	Sugar	Egg, vanilla essence, real mix juice, peanut butter and baking powder	180°C for 15-18mins	Ravi, <i>et al.</i> , 2018. [10]
3	Multigrain cookie	Wheat flour, chickpea flour, maize flour,	Vegetable oil	Sugar	Sodium bicarbonate, ammonium	180-200°C for 10-13mins	Naval, <i>et al.</i> , 2018. [11]

		finger millet flour, pearl millet flour and barley flour			bicarbonate, salt, vanilla and baking powder		
4	Sweet potato and maize flour blend cookie	Sweet potato flour and maize flour	Margarine	Sugar	Whole egg, powdered milk, salt and baking powder	150°C for 20 mins	Samuel& John, 2016. [12]
5	Multigrain cookie	Wheat flour and malted barley bran	Ghee	Sugar	Powdered milk, baking powder and salt	220° at 20 mins	Ikuomola <i>et al.</i> , 2017. [13]
6	Multigrain cookie	Wheat flour, sweet detar flour and moringa leaf flour	Vegetable oil	Sugar	Salt and baking powder	160°C for 20 mins	Bibiana <i>et al.</i> , 2018. [14]
7	Multigrain cookie	Wheat flour and cooking banana flour	Margarine	Sugar	Egg, vanilla flavour, salt and baking powder	180°C for 10-15 mins	China <i>et al.</i> , 2020. [15]
8	Cookies incorporate with oats and honey	Rolled oats flour and wheat flour	Vegetable oil	Sugar	Egg and baking powder	175°C for 10-15 mins	Bornare, 2015. [16]
9	Gluten free millet cookies	Ragi, sorghum and oats	Butter	Honey	Dark chocolate, baking powder and baking soda	150-180°C for 15-20 mins	Meenu, <i>et al.</i> , 2018. [17]
10	Multigrain cookie from buckwheat-barley composite flours	Wheat flour, ragi flour and buckwheat flour	Vegetable oil	Sugar	Apricot powder and sodium bicarbonate	160°C for 15 mins	Anwar, <i>et al.</i> , 2018. [18]
11	Multigrain gluten free cookie	Finger millet, pearl millet, groundnut powder and soya bean flour	Vanaspati	Sugar	Glucose, skimmed milk powder, ammonium bicarbonate and sodium bicarbonate	205°C for 7-8 mins	Radhika <i>et al.</i> , 2019. [19]
12	Bagasse fiber mixed jaggery based cookies	Wheat flour	Butter	Jaggery	Sodium bicarbonate	100°C for 25 mins	Anwar <i>et al.</i> , 2017. [43]

### Nutritional factors of Multigrain cookies:

Cookies are usually prepared from wheat flour and production of cookies from wheat flour is lacking in numerous nutrients counting some proteins, vitamins, mineral elements as well as dietary fibers. Which benefits in the reducing cholesterol, heart diseases and causes low obesity levels. Till now there are some products like biscuits, cookies, and breads which are fortified with some of the multigrain for dietary fiber, protein, carbohydrates and other minerals such as potassium, Fe, Zn etc, and having good anti - oxidant properties. In many of the papers the multigrain used are finger millet flour, pearl millet flour, maize flour, foxtail flour, flaxseed flour, oats flour and barley flour. These are rich in nutrients such as vitamins, minerals, proteins as well as dietary fibers. The flaxseed and foxtail millet flour are rich in carotenoid, lycopene, dietary fibers and omega-3 fatty acids. These multigrain has many health benefits such as helps in prevention of various diseases cancer, osteoporosis, helps in digestion and also plays a major role in preventing metabolic disorder like diabetes, helps to reduce cholesterol, lowers the risk of obesity, boosts immune system. They have anticarcinogenic and antitoxic activity.

**Table 2.3: Nutritional factors of multigrain cookies**

SL. NO	Name of the cookie	Value added ingredient	Nutritional factors	Health benefit	Reference
1	Multigrain cookies	Corn flour and barley flour	These are significant source of B-complex vitamins, tocotrienols and tocopherols	Helps to lower plasma cholesterol, improves lipid metabolism and boosts immune system	Khushboo, <i>et al.</i> , 2022. [20]
2	Cookies incorporating pumpkin seed flour	Whole wheat flour and pumpkin seed	Pumpkin seeds are rich in nutrients,	Lower the chances of occurrence of	Neeta, <i>et al.</i> , 2021. [21]

		flour	medicinal properties, protein, oil, minerals and dietary fibers	many types of cancers such as lung and gastric cancer	
3	Beta-carotene contents of cookie	Verities cassava flour	Provitamin A carotenoid	Help to tackle vitamin A deficiency	Ndulaka, <i>et al.</i> , 2018. [22]
4	Multigrain cookies incorporating wheat grass powder	Ragi, barley, jowar, bajra, soya bean and wheat grass powder	Excellent source of vitamins, minerals, antioxidant, amino acids, protein, chlorophyll and active enzymes	Used for the treatment of acidity, colitis, astringent, laxative, diuretic and antibacterial	Manohar, <i>et al.</i> , 2021. [23]
5	Organic jaggery based millet cookies	Little millet and organic jaggery	It has several nutritional and medicinal properties	Anti-toxic activity and has anti-carcinogenic activity	Mahalaxi, <i>et al.</i> , 2019. [24]
6	Oat and finger millet cookie	Oats and finger millet	Rich in dietary fibers, phytochemicals and nutritional value	Lowering the cholesterol and reducing risk of heart disease	Giram, <i>et al.</i> , 2017. [25]
7	Multigrain cookies	Flaxseed flour, foxtail millet flour, carrot flour and rice bran oil	Rich in carotenoid, lycopene, dietary fibers and omega-3 fatty acids	Helps in prevention of various diseases cancer, osteoporosis, helps in digestion and also plays a major role in preventing metabolic disorder like diabetes	Daisy, <i>et al.</i> , 2017. [26]
8	Protein enriched multigrain cookies	Wheat flour, finger millet flour and barley flour	Rich in nutrients such as vitamins, minerals, proteins as well as dietary fibers	Helps in reducing cholesterol, heart diseases and causes low obesity levels	Hemanth, 2020. [27]

#### Proximate analysis of Multigrain cookies:

Proximate analysis includes estimation of moisture content, total ash, acid insoluble ash, acidity of extracted fat, carbohydrate content, total fat and protein estimation. Proximate analysis helps to know the nutritional contents present in the developed product. Moisture content is the amount of water present in a product. It is normally estimated by weight loss upon drying. The most common method used for the determination of moisture content in product is oven drying method. Total ash is a number of the mineral oxide content of stimulated carbon on a weight basis. It is measured by altering the mineral elements to the particular oxides at 500°C. The ash includes mostly silica and aluminium and the number is dependent on the base raw material used to yield the product. Total ash is determined in a muffle furnace. Total fat specifies the number of fats contain in the product. Fat is usually estimated by using Soxhlet extraction method. Determination of protein content is carried out by using Kjeldahl process. Estimation of carbohydrate content is carried out by using phenol-sulphuric method. In the papers the moisture content ranges from 1.13% to 9%. Total ash content varies from 0.97% to 1.5. Fat differs from 0.56% to 27.62%. Protein varies from 3.1% to 50.98%. carbohydrate content varies from 47.85% to 83%.

**Table 2.4: Proximate analysis of Multigrain cookies**

SL. NO.	Name of the cookie	Moisture	Ash	Fat	Protein	Carbohydrate	Reference
1	Finger millet cookies	4.0%	1.50%	19.6%	6.5%	76.4%	Bhoite, <i>et al.</i> , 2018. [28]
2	Cookies supplemented with cassava flour and water chestnut flour	9.0%	1.42%	0.56%	3.1%	83%	Anu, <i>et al.</i> , 2015. [29]
3	Pumpkin and carrot cookies	3.23%	1.98%	9.22%	9.04%	78.6%	Nonny, <i>et al.</i> , 2021. [30]
4	Multigrain cookies	8.17%	1.63%	27.62%	18.45%	47.85%	Veer, <i>et al.</i> , 2018. [9]
5	Multigrain cookies	4.5%	0.97%	22.5%	8.9%	64.33%	Khushboo, <i>et al.</i> , 2022. [20]
6	High protein cookie	1.33%	1.14%	21.51%	6.83%	69.38%	Nehir, <i>et al.</i> ,

							2018. [7]
7	Hight protein and low-calorie cookie	4.5%	1.4%	21.6%	10.5%	66.8%	Amit, et al., 2011. [6]
8	Multigrain cookies incorporating different flour blends	4.61%	1.24%	7.12%	50.98%	76.02%	Ravi, et al., 2018. [10]
9	Multigrain cookies	3.87%	1.37%	16.32%	12.60%	66.90%	Naval, et al., 2018. [11]
10	Protein enriched multigrain cookies	4.0%	1.68%	17.20%	10.77%	57.06%	Hemanth, 2020. [27]
11	Chia and quinoa seed flour cookies	2.28%	1.24%	20.59%	7.72%	69.82%	Jyoti, et al., 2018. [31]

### Sensory methods used to evaluate the Multigrain cookies:

Sensory evaluation of a product is conducted by a panel of specialists and the affecting test conducted out on customers, allow to gather added data about the product being analysed, its superiority and to validate features inducing its satisfactoriness by clients, which allows work on enlightening the eminence of the product or its reformulation. The number of panelists depends. The attributes considering for the evaluation of the product depends on the type of the product. The attributes usually include taste, color, appearance, texture, mouth feel after tasting, crispiness, flavour, aroma and overall acceptability. The most common sensory method used in most of the papers for the evaluation of product is 9- point hedonic scale. It ranges from 1-9 rating. 1= dislike extremely, 2= Dislike very much, 3= Dislike moderately, 4= dislike slightly, 5= neither dislike nor like, 6= like slightly, 7= like moderately, 8= like very much and 9= like extremely. The outcomes got from hedonic scale are the scores that customer gives to each product. Depending on these statistics the average values of suitability for each product and whether there are noteworthy alterations in the suitability of the product is decided.

**Table 2.5: Sensory methods used to evaluate the Multigrain cookies**

SL. NO	Sensory method used	No. of panelists involved	Attributes considered	Reference
1	5-point hedonic scale	15	Physical appearance, mouth feel, color, oiliness and stickiness	Anu, et al., 2015. [29]
2	9-point hedonic scale	20	Appearance, taste, texture, crispiness and general acceptability	Laura, et al., 2013. [32]
3	9-point hedonic scale	30	Taste, aroma, color, crispiness and overall acceptability	Zain, et al., 2022.[33]
4	9-point hedonic scale	30	Color, texture, flavour, appearance and overall acceptability	Jyoti, et al., 2018. [31]
5	9-point hedonic scale	10	Surface color, appearance, taste, odour, interior colour, texture, and overall acceptability	Wallaa, et al., 2018. [34]
6	9-point hedonic scale	30	Taste, color, texture, crispiness, flavour and overall acceptability	Thivani, et al., 2016. [35]
7	7-point hedonic scale	12	Color, flavour, taste, texture and overall acceptability	Hawine, et al., 2017. [36]
8	9-point hedonic scale	10	Taste, color, texture, crispiness, appearance and overall acceptability	Samuel&John, 2016. [12]

### Shelf-life studies of Multigrain cookies:

Shelf life of cookies states to the duration for which they can be utilized while preserving the food quality. Extrinsic factors such as, relative humidity, storage temperature including some of inherent factors of cookies regulates the shelf-life of cookies. The shelf-life of cookie starts from the moment it has prepared. Its shelf-life is rely on many aspects together with the type of components, manufacturing method, form of packaging and how the cookies are warehoused. In most of the papers, cookies shelf-life is evaluated on the basis of nutritional qualities, sensory qualities, microbial count, moisture, free fatty acids and peroxide value. In most of the works, shelf-life is evaluated on the basis of nutritional qualities. In nutritional qualities moisture plays a very important role. Moisture content i.e., water activity results in degrading of food as it causes microbial attack very easily. The Acidity of extracted fat is another parameter where the value of it denotes the extent of the rancidity of the cookie. As the acidity of extracted fat increases the rancidity also increases that results in bad odour and off flavour. In most of the work the shelf-life is evaluated in the range of 30 days to 120 days. Most of the papers evaluated for 60 days. The cookies were stored in a different type of containers such as polyethene zipper bags, aluminium foil, air tight container, Polypropylene pouches and laminated plastic

pouches. The cookies were stored at 30 to 40°C. In most of the works the cookies were warehoused at room temperature in a close-fitting vessel.

**Table 2.6: Shelf-life studies of Multigrain cookies**

SL NO.	Name of the cookie	Storage period	Type of packaging used for storage	Attributes evaluating for shelf-life	Storage temperature	Reference
1	Cookies produced from composite blends of wheat and sweet potato flour	6 months	Sealed laminate aluminium foil	Physio-chemical and organoleptic qualities	30°C	Jemziya, and Mahendra, 2017. [37]
2	Gluten free millet cookies	60 days	Air tight container	Nutritional and sensory qualities	Room temperature	Menu, <i>et al.</i> , 2018. [17]
3	Pineapple powder incorporated cookies	6 weeks	Laminated plastic pouches	Nutritional and sensory qualities	31°C	Thivani, <i>et al.</i> , 2016. [35]
4	Multigrain cookies	60 days	Polypropylene pouches	Moisture content, peroxide value, free fatty acids, sensory evaluation and microbiological quality	Room temperature	Jyoti, <i>et al.</i> , 2018. [31]
5	Cookies incorporating pumpkin seed flour	75 days	Polythene zipper bag	Sensory characteristics, peroxide value and microbial count	Room temperature	Neeta, <i>et al.</i> , 2021. [21]
6	Millet cookies	90 days	Air tight container	Nutritional and sensory qualities	Room temperature	Gunaseelan and A. Arun, 2021. [38]
7	Cookies from buckwheat-barley composite flour	90 days	Polyethene zipper bag	Nutritional qualities	Room temperature	Anwar, <i>et al.</i> , 2018. [18]
8	Almond pastry cookies	45 days	Aluminium foil	Nutritional qualities	30°C	Romeo, <i>et al.</i> , 2010. [39]

### III. MATERIALS AND METHODOLOGY

#### 3.1 Collection and Selection of the Materials:

Ingredients selected in the present studies are whole wheat flour, finger millet flour, rolled oats flour, chia seeds, jaggery powder, sunflower oil, cardamom, cashew, almonds, baking powder and baking soda which are purchased from grocery shop at Vidyagiri, Bagalkote.

#### 3.2 Formulations for preparation of cookies:

The multigrain cookies were prepared in four different formulations to check which among them are tasty and nutritionally has extra health benefit. The flours such as whole wheat flour, finger millet flour and oats flour have taken in different proportions for the preparation of cookies. The other ingredients were kept constant. The formulations for the preparation of cookies were given below:

**Table 3.1: Cookies with different formulations**

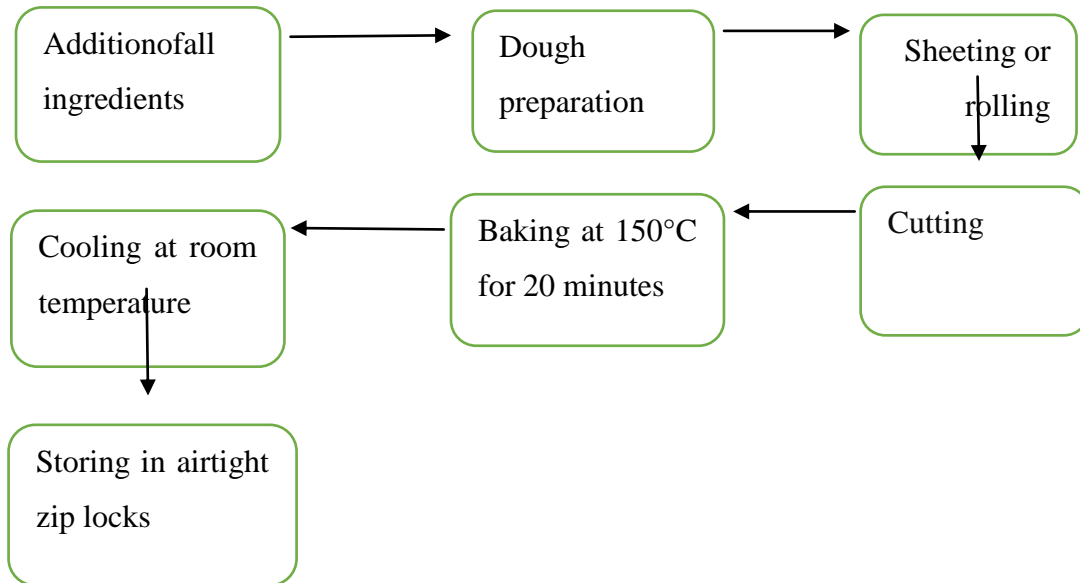
Sl. No	Formulations	Whole wheat flour (WWF) in gms	Finger millet flour (FMF) in gms	Oats flour (OF) in gms
1.	C1	40	15	15
2.	C2	15	40	15
3.	C3	15	16	40
4.	C4	23.3	23.3	23.3

#### 3.3 Preparation of cookies

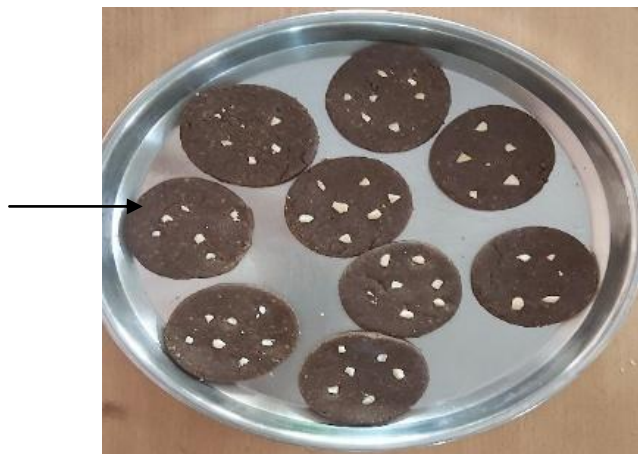
Initially the rolled oats were grinded into flour. Dry fruits such as almonds and cashews along with the chia seeds were grinded into powder. All the ingredients such as wheat flour, finger millet flour, oats flour, chia seeds, jaggery powder, cardamom, almond, cashew and baking powder were weighed, mixed with water and kneaded properly to form a dough. The standing time given for the dough was 5 minutes as all the flours has high capacity of water absorption. After that, the dough was rolled or sheeted to cut them in cookie shape. After cutting them, they were garnished with dry fruits to catch the customer's eyes. Now, the cookies were baked at a temperature of 150°C for about 20 minutes. After baking the cookies were allowed for cooling for 5-8 minutes. Cooling is important for confirming the substantial loss of the moisture from the cookies. After cooling, the



cookies were packed and warehoused in a polyethylene zipper bag. Further the cookies were taken for sensory evaluation and proximate analysis. This process is also shown in the below flowchart.



a. Dough preparation



b. Cutting of cookies



d. Cookies after baking



c. Baking at 150°C for 20 minutes

Fig 3.1: preparation of cookies

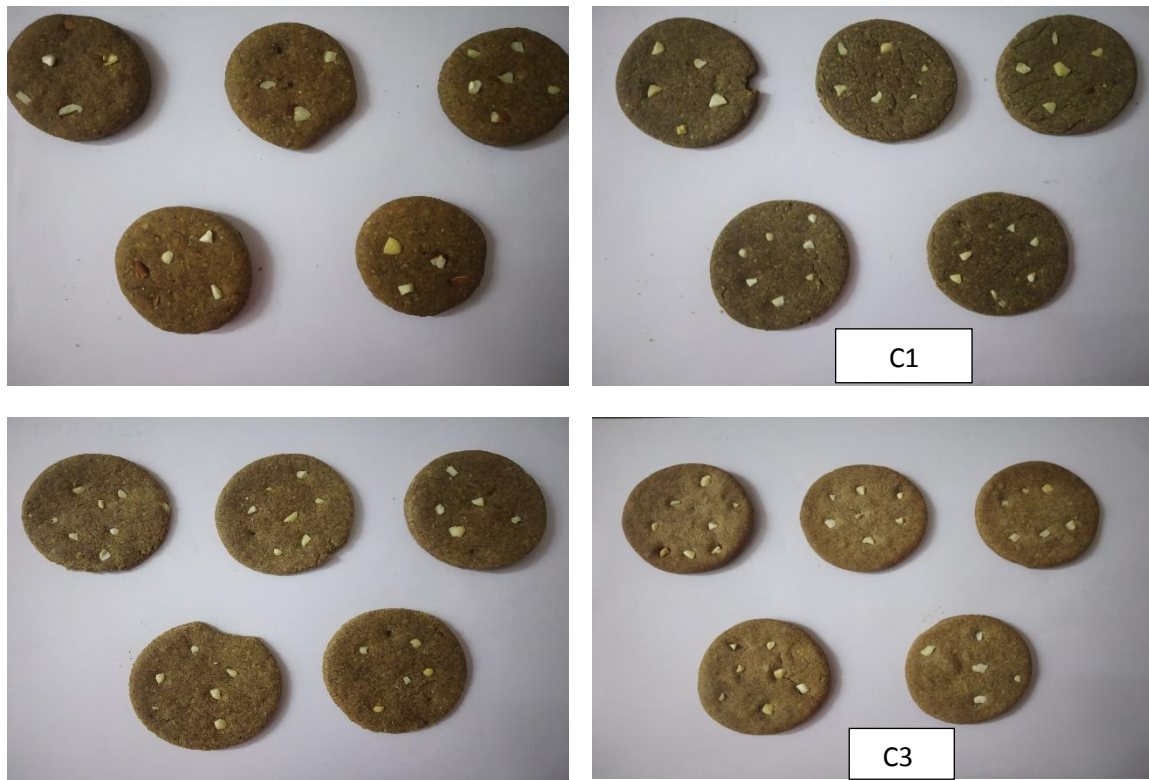


Fig 3.2: Cookies of different formulations as per table 3.1

### 3.4 Sensory Evaluation

Sensory assessment is a science that measures, examines, and interprets the responses of individuals to products as perceived by the senses. The key purpose of sensory analysis are to:

- Choose qualified juries and learn human remark of food features
- Compare sensory with chemical and physical dimension
- learn processing effects, keep quality, check raw material choice, create storage constancy
- Assess quality of the product or regulate consumer reaction against the product

Multigrain cookies prepared by using whole wheat flour, finger millet flour and oats flour was served to panel members consisting of 15 members which includes students and staff using 5-point hedonic scale (5-like extremely, 4- like moderately, 3- neither like nor dislike, 2- dislike moderately, 1- dislike extremely). All the samples were evaluated for color, taste, mouth feel, aroma and texture. [29]

The evaluation procedure was clarified to all the members present for the evaluation. The test was directed in midmorning after 3-hour gap from tiffin. Cookie samples were given to the panel members and adequate amount of period was given to avoid any misconception. Water was given to rinse the mouth after every sample was tasted. The finest fused cookie samples were recognised depending on their sensorial satisfactoriness and studied more for their nutritional assessment. Sensory evaluation sheet is prepared to get the information. The sensory evaluation sheet is attached below:

#### HEDONIC RATING OF FOOD PRODUCT

Basaveshwar Engineering College (Autonomous), Bagalkote  
Department of Biotechnology

Sensory evaluation of Multigrain Cookies

NAME:

Attributes	C1	C2	C3	C4
Color (Appearance)				
Taste				
Mouth feel				

Aroma				
Texture				
Acceptability				
Preference				

Signature



Fig 3.3: Panelists tasting the samples

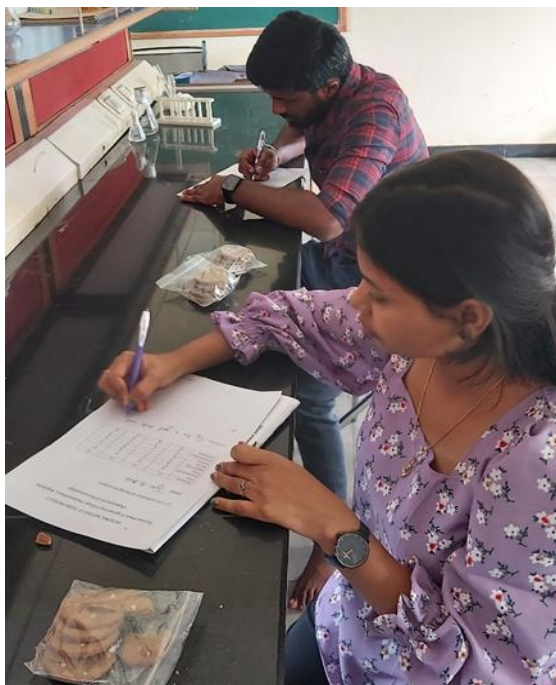


Fig 3.4: Sensory Evaluation

### 3.5 Proximate analysis of the developed product

Proximate examination refers for a process, which governs the values of the macronutrients in food samples. In universal, those values are being specified as nutritional proofs shown generally on the tags of the finished or end food products, but they are also being estimated during the manufacture procedure. The start of the nutritional investigation initiates back in 1861 and later then it has been endlessly advanced, improved and upgraded.

### 3.5.1 Estimation of Moisture content [9]

Moisture estimation is most vital and broadly used dimensions in the testing and processing of foods. Moisture is the volume of water available in a sample, articulated as a percentage. Moisture content shows a noteworthy role in founding proper circumstances for storability, preservation and packaging of food products.

Sample was prepared by grinding the cookie with mortar pestle. Moisture was determined by Oven drying method. Firstly, empty Petri dish was weighed (W1), then approximately 10gm of prepared sample is added to the Petri dish and weight was noted (W2). Now, the Petri dish is kept in oven for 4 hours at 105°C. After 4 hours the Petri dish is taking out from the oven and kept in desiccator to bring it down to room temperature. Now, the cooled Petri dish is weighed (W3). The moisture content is determined by using the formula as given below

$$\text{Moisture (\%)} = [(W2-W3)/(W2-W1)] \times 100$$

Where,

W1= Weight of empty Petri-dishes

W2= Weight of Petri-dishwith sample before drying

W3= weight of Petri-dish with the sample after drying



Fig 3.5: Hot Air Oven

### 3.5.2 Estimation of Total Ash content [9]

Ash states to the inorganic remainder remaining later ignition of organic stuff in a food sample. Estimating the total ash content of a food is a portion of proximate investigation for nutritional assessment and it is often vital quality characteristic for some food trials. Ash content reflects the quantity of mineral matter present in materials.

Estimation of ash is carried out using muffle furnace. Firstly, empty crucible weight is noted (W1), then 5 gm of sample is added to the crucible and weight (W2) is noted. Now keep the crucible in muffle furnace at 550°C for about 4 hours. After 4 hours take out the crucible with the help oftongs and keep in desiccator to bring it down to the room temperature. Now, the crucible is weighed (W3). The total ash content is determined by using the formula given below:

$$\text{Ash (\%)} = [(W3-W1)/(W2-W1) (100-M)] \times 10000$$

Where,

W1= Wight of empty crucible

W2= Weight of crucible with the sample taken for the test

W3= weight of crucible with ash

M= Moisture content of the sample



Fig 3.6: Muffle furnace



Fig 3.7: Muffle furnace inside view

### 3.5.3 Estimation of Acid insoluble ash [9]

Acid insoluble ash indicates the amount of siliceous matter present in the sample. Higher quantities of acid insoluble ash is injurious to health.

5 grams of sample is used to find ash content. The ash obtained is used to find acid insoluble ash. To the ash contained in the crucible add 5 ml of diluted HCl. Filter the insides in the crucible using a Whatman filter paper. Wash the filter paper using distilled water till the washings are able to free from the acid and return them to the crucible. Keep it in muffle furnace at 550°C for about 3 hours. After 3 hours, take out the crucibles with the help of tongs and keep in desiccator to bring it down to room temperature. Now, weigh the crucible and note the reading. Acid insoluble ash is determined by using the formula given below:

$$\text{Acid insoluble ash (\%)} = \frac{(W_4 - W_1)}{(W_2 - W_1)(100 - M)} \times 10000$$

Where,

W1= Empty crucible weight

W2= Weight of crucible with the sample taken for the test

W4= weight of crucible with acid insoluble ash

M= Moisture content of the sample



Fig 3.8: Estimation of acid insoluble ash

### 3.5.4 Estimation of fat content [9]

Amount of fat content in the sample is determined by Soxhlet process. Fat content is estimated by extracting the fat from sample using petroleum ether as a solvent, then determined the weight of the fat recovered.

Using a mortar and pestle, grind the sample into pieces so that it could fit into the extraction thimble. Weigh the empty thimble (W1), add approximately 10 grams of sample into the thimble and note the weight (W2). Weigh the empty round bottom flask (RBF1). Measure between 150 ml of petroleum ether into the round bottom flask. Place it on the heating mantle. Assemble the Soxhlet apparatus on a working table making sure to clamp everything is properly placed. Turn on the heat source and set the temperature to 70°C as it is a boiling temperature of petroleum ether. Extract the sample for 3 hours. At the last of extraction period, take away the

thimble and distill off most of the petroleum ether by allowing it to gather in the Soxhlet tube. Kept on heating mantle for 5 minutes to completely evaporate the sample. Weigh the flask and note the reading (RBF2). Fat content is determined by using following formula:

$$\text{Fat (\%)} = [(T2-T1)/(RBF2-RBF1)] \times 100$$

Where,

T1= empty thimble weight

T2= thimble weight with sample

RBF1= empty round bottom flask

RBF2= round bottom flask weight after recovering the solvent



Fig 3.9: Soxhlet apparatus

### 3.5.5 Estimation of acidity of extracted fat [9]

The measure of fat acidity reflects the number of fatty acids which is present in oils/fats. It is a continued procedure of fat determination process.

Once the fat is extracted by Soxhlet method, to the fat obtained in the round bottom flask add 50 ml of 95% of ethanol and add 4-5 drops of phenolphthalein indicator. Titrate it in contrast to 0.05 N of NaOH until it turns to pink color. Acidity of extracted fat is calculated by using the following formula:

$$\text{Acidity of extracted fat} = (TV \times \text{normality of NaOH} \times 28.2) / (RBF2 - RBF1)$$

Where,

TV= Titre value

RBF1 = Empty round bottom flask

RBF2 = Round bottom flask weight after recovering the solvent

Note: Since the fat is less in the round bottom flask, hence the same round bottom flask is used for the titration.

### 3.5.6 Estimation of protein content[9]

Protein was estimated by Kjeldahl process which comprises a three-step method to the quantification of protein that is digestion, distillation and titration. The principle includes, digestion of carbon-based material is attained using concentrated acid and a catalyst to rapid up the reaction. The food releases nitrogen which can be estimated with the suitable titration method. The total amount of protein available in the food is then determined from the nitrogen concentration present in the food sample.

The food sample was grinded into powder and weighed 0.1 grams. Totally 6 digestive flasks were there in the apparatus, where first tube was taken as blank (no test samples were added). To the digestion flask 0.5 grams of copper sulphate, 4 grams of potassium sulphate and 15 ml of concentrated HCl were added. The digestion tubes were kept for digestion process for one and half hour. Once the digestion process completes, the digestion tubes were allowed for cooling at room temperature. Then, add 50ml of 2% of boric acid in a conical flask and few droplets of methyl red indicator and then kept it for neutralization process against 50% of NaOH. After completion of neutralization process, the conical flask is taken and titrated against concentrated HCl.

#### Calculation:

$$\text{Nitrogen (\%)} = [(TV - \text{Blank}) \times N \text{ of HCl} \times 0.014 / \text{weight of sample}] \times 100$$

Where,

TV= titre value

$$\text{Protein (\%)} = N\% \times 6.25$$



Fig 3.10: Kjeldahl apparatus

### 3.5.7 Estimation of total carbohydrate content[9]

The phenol-sulphuric method was used for the estimation of carbohydrate content present in the developed multigrain cookies. This method detects all classes of the carbohydrate which includes mono, di, oligo and polysaccharides.

**Sample preparation:** The cookie was grinded into powder by using mortar and pestle. 0.1 gm of cookie was weighed. This 0.1 gm of sample was diluted in 50 ml of water. It is vortexed for 5 minutes to homogenise the mixture. From this mixture 0.1 ml of sample was taken for the estimation of carbohydrate.

The glucose standard was prepared. The glucose standard prepared was 25 µg/ml/100ml. For standard, 6 clean test tubes were taken. To each test tube 0, 0.2, 0.4, 0.6, 0.8 and 1ml of standard glucose was added. Then, 1, 0.8, 0.6, 0.4, 0.2 and 0ml of distilled water was added to each test tube respectively. Then, another 4 test tubes were taken for the test samples. To each test tube 0.1ml of prepared sample was added. To each test tube 1ml of 5% phenol and 5ml of concentrated sulphuric acid was added. All the 10 test tubes were incubated at room temperature for 20 minutes. After 20 minutes the color turned into orange brown. Then, the O.D i.e., optical density was read through colorimeter at 490 nm.

#### Calculation:

Carbohydrate (%) = (Unknown O.D × dilution factor × 100) / sample weight

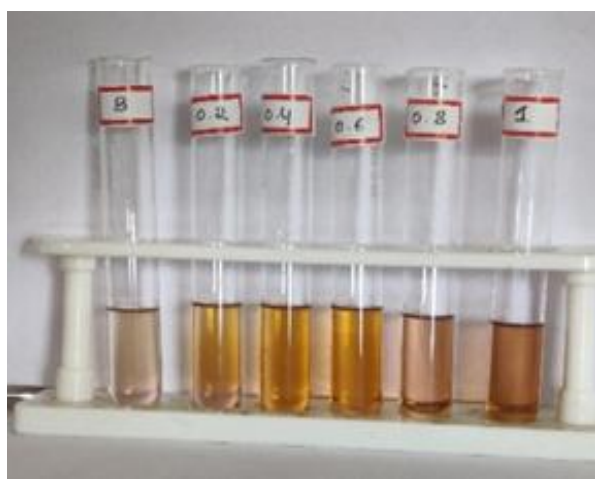


Fig 3.11: Standard Glucose



Fig 3.12: colorimeter

### 3.7 Shelf-life studies of developed multigrain cookies [35]

Shelf life is a significant asset of any food and is of attention to everybody in food chain right from the makers to customer. Well-arranged and conducted customer suitability tests in the form of proper sensory analysis, is a significant portion of the shelf-life assessment of any of the product. Water vapor and moisture transmission act as main influencing features for shelf life. Physicochemical variations in food during storing can be the reason for damage of shelf-life resulting in deterioration of its superiority. Water is an essential for food which influences food safety, stability, excellence and physical properties. Amplified moisture of food

due to water absorption from the surroundings or by mass conveyance from adjoining components outcomes in a soft texture and soggy. Off-flavours, off-odours and damage to crispiness in wrapped foods are the chief reason behind customer rejection. These may be brought about by oxidative rancidity of wrapped foods, migration, permeation and reactions among food components with the packaging components.

In the shelf-life study of Multigrain cookies, which were prepared as described in 3.3 and stored in air tight polyethylene zipper bag at room temperature. The shelf-life study of the Multigrain cookies were carried out for a duration of 1 month. The parameters involved for the study of Multigrain cookies were moisture, acidity of extracted fat and taste. The shelf-life study was carried out once in a week for about 1 month.

For the estimation of moisture content in the multigrain cookies, oven method is used. for determination of acidity of extracted fat of multigrain cookies, Soxhlet method was used followed by titration method.

IV. RESULTS AND DISCUSSIONS

4.1 sensory evaluation

Table4.1: sensory scores of the formulation of sample C1

Attributes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total sum	Mean
Appearance	3	3	3	4	3	3	3	2	3	4	3	2	3	3	3	45	3.0
Taste	3	2	3	3	2	2	3	3	3	2	3	3	2	3	3	40	2.66
Mouth feel	3	3	3	2	2	3	2	3	2	3	3	2	3	2	3	39	2.6
Aroma	4	3	3	3	4	4	4	4	3	4	4	4	4	4	4	56	3.73
Texture	4	3	4	3	3	3	3	4	4	3	2	2	2	3	2	45	3
Acceptability	3	3	2	3	3	3	2	3	2	3	2	3	3	3	3	41	2.73

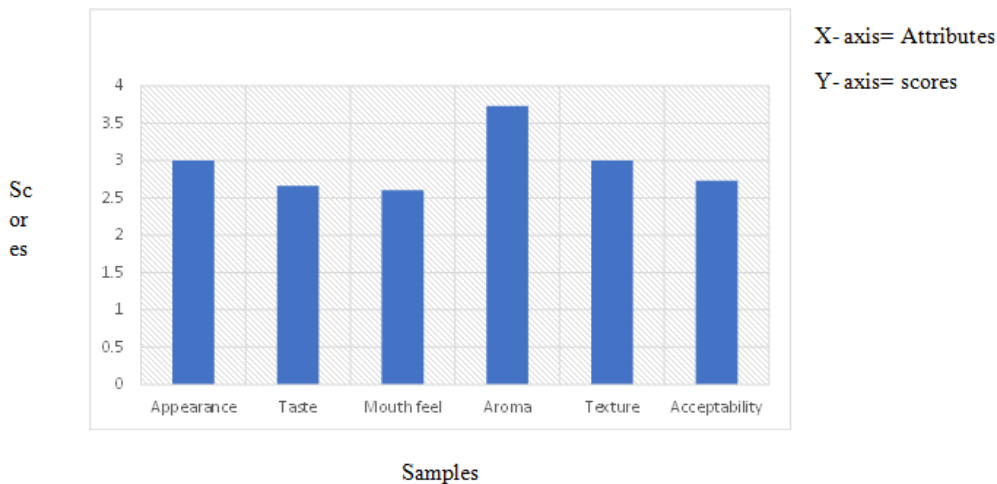


Fig 4.1: Graphical representation of acceptability of sample C1

Hedonic 5-scale rating method was carried out. In this formulation, 40gm of wheat flour, 15gm of finger millet flour and 15gm of oats flour were added. Among all the attributes aroma was scored high and mouth feel was scored low. The highest score given for the sample was 3 i.e., for appearance and texture. The lowest score given was 2.6. i.e., for mouth feel. Appearance was neither liked nor disliked. Taste was moderately disliked. Mouth feel was moderately disliked. Aroma was moderately liked. Texture was neither liked nor disliked. The overall acceptability for the sample C1 given was 2.7 i.e., the sample was neither liked nor disliked by the panelists.

Attributes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total sum	Mean
Appearance	4	4	4	5	4	4	4	4	4	4	5	4	4	4	4	62	4.13
Taste	5	4	4	4	5	4	4	3	4	5	4	4	5	5	4	64	4.26
Mouth feel	4	3	4	5	5	4	5	4	4	4	4	4	5	5	4	64	4.26
Aroma	4	4	4	4	4	4	4	4	5	4	4	4	5	4	5	63	4.20
Texture	4	5	4	5	4	4	4	4	4	5	4	4	3	4	4	62	4.13
Acceptability	3	4	5	4	5	4	4	5	4	4	5	4	4	5	4	64	4.26

Table4.2: Sensory scores of the formulation of sample C2



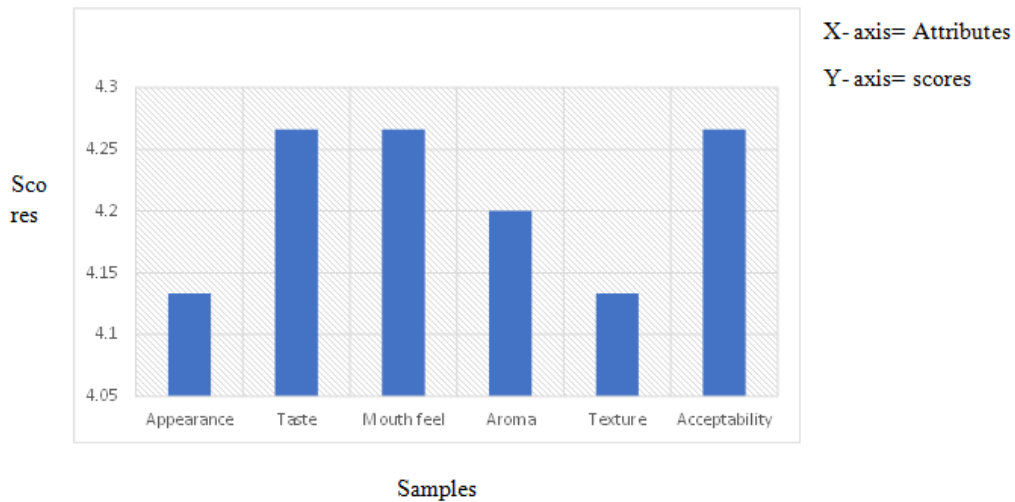


Fig 4.2: Graphical representation of acceptability of sample C2

Hedonic 5-scale rating method was carried out. In this formulation, 40gm of finger millet flour, 15gm of wheat flour and 15gm of oats flour were added. Taste and mouth feel was equally liked by the panelists. Among all the attributes texture and appearance were scored low. The highest score given for the sample C1 was 4.2. i.e., for aroma and taste. The lowest score given for the sample C2 was 4.1. i.e., appearance and texture. Appearance was moderately liked. Taste was moderately liked. Mouth feel was moderately liked. Aroma was moderately liked. Texture was moderately liked. The overall acceptability for the sample C2 given was 4.4 i.e., the sample was moderately liked by the panelists.

Table 4.3: Sensory scores of the formulation of sample C3

Attributes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total sum	Mean
Appearance	3	3	3	3	3	2	3	2	3	3	3	3	4	3	3	44	2.93
Taste	2	2	3	3	3	3	1	2	2	3	3	3	3	1	4	40	2.66
Mouth feel	2	2	3	2	2	3	3	3	2	2	2	1	2	3	3	35	2.33
Aroma	3	3	3	3	3	3	2	2	2	3	3	2	2	4	3	41	2.73
Texture	3	3	4	3	3	3	2	3	3	3	3	2	3	3	3	44	2.93
Acceptability	3	2	3	2	3	3	3	3	3	2	2	3	1	3	3	39	2.60

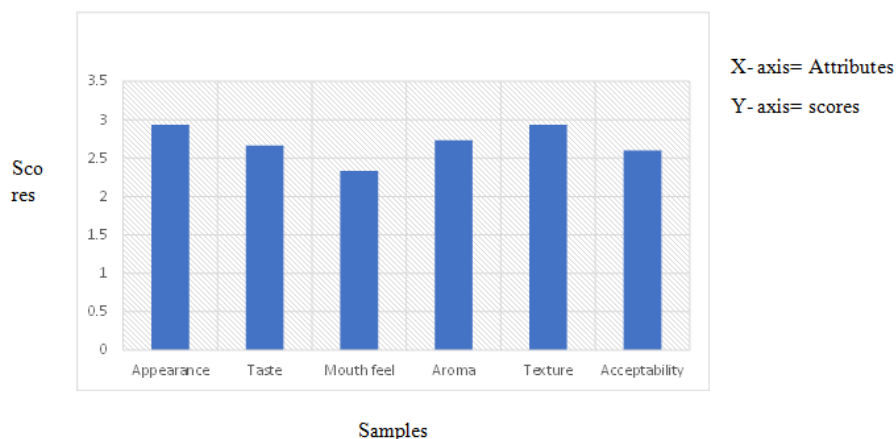


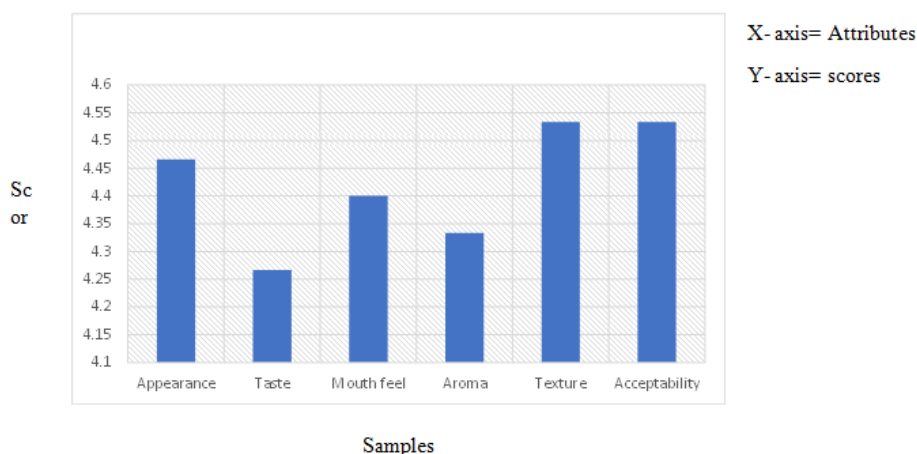
Fig 4.3: Graphical representation of acceptability of sample C3

Hedonic 5-scale rating method was carried out. In this formulation, 40gm of oats flour, 15gm of wheat flour and 15gm of finger millet flour were added. Among all the attributes mouth feel was scored low and appearance and texture were scored high. The highest score given for the sample C3 was 2.9. i.e., for texture and appearance, the lowest score given for the sample C3 was 2.3. i.e., for mouth feel. Appearance was neither liked nor disliked. Taste was neither like nor disliked. Mouth feel was moderately disliked. Aroma was neither liked

nor disliked. Aroma was neither liked nor disliked. The overall acceptability for the sample C3 given was 2.6 i.e., the sample was neither liked nor disliked by the panelists.

**Table4.4: Sensory scores of the formulation of sample C4**

Attributes	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total sum	Mean
Appearance	4	4	5	5	5	5	5	5	4	4	4	4	4	4	5	67	4.46
Taste	4	4	4	5	3	5	4	4	4	3	4	5	5	5	5	64	4.26
Mouth feel	4	4	4	4	4	4	5	5	5	5	4	4	4	5	5	66	4.40
Aroma	4	4	4	4	4	5	5	5	5	4	4	4	5	4	4	65	4.33
Texture	4	4	5	5	4	4	4	4	4	5	5	5	5	5	5	68	4.53
Acceptability	4	4	4	5	5	5	5	5	5	5	5	4	4	4	4	68	4.53



**Fig 4.4: Graphical representation of acceptability of sample C4**

Hedonic -scale rating method was carried out.in this formulation, al the 3 flours were added equally i.e., 23.3gm of wheat flour, 23.3gm of finger millet flour and 23.3gm of oats flour were added. Among all the attributes texture was scored high and taste was scored low. The highest score given for the sample C4 was 4.5. i.e., for texture. The lowest score given for the sample C4 was 4.2. i.e., for taste. Appearance was extremely liked. Taste was moderately liked. Mouth feel was moderately liked. Aroma was moderately liked. Texture was extremely liked. The overall acceptability for the sample C4 given was 4.5 i.e., the sample C4 was extremely liked by the panelists.

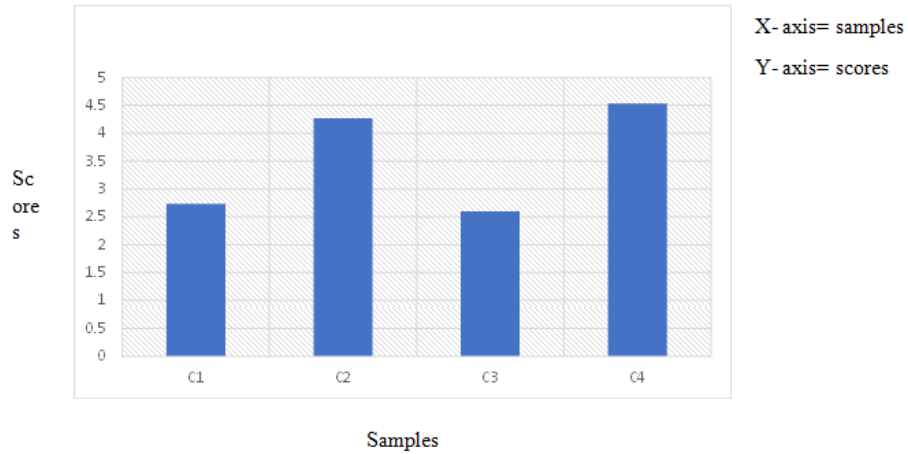


Fig 4.5: Overall acceptability of all formulations

The overall acceptability for the sample C1, C2, C3, and C4 were 2.7, 4.2, 2.6 and 4.5 respectively. Sample C1 and sample C3 were neither liked nor disliked by the panelists. Sample C2 was moderately liked by the panelists. Sample C4 was extremely liked by the panelists.

**4.2 Moisture content**

The moisture content of the multigrain cookies were estimated by the standard oven method where the Petri dishes were kept in oven for 4 hours at 105°C. After 4 hours the petri dishes were taken out and noted the W3 weight. The moisture content was calculated by using the formula. The moisture content the cookies were given below in the table.

Table4.5: Moisture content of the multigrain cookies of all the 4 formulations

SL. No	Formulations	Moisture (%)
1	C1	3.673
2	C2	3.419
3	C3	3.774
4	C4	3.391

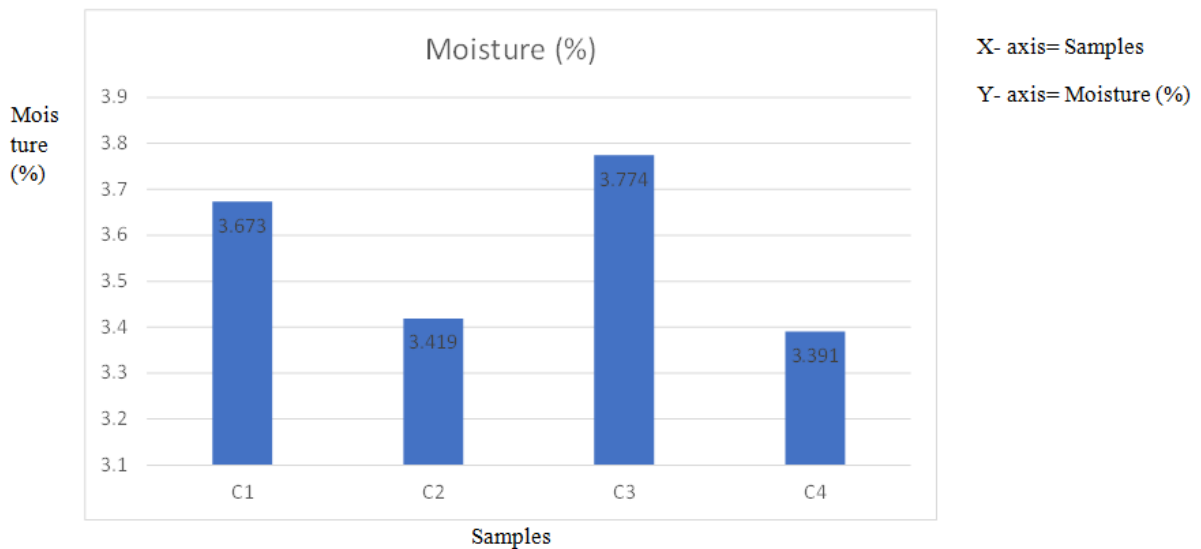


Fig 4.6: Graphical representation of moisture content

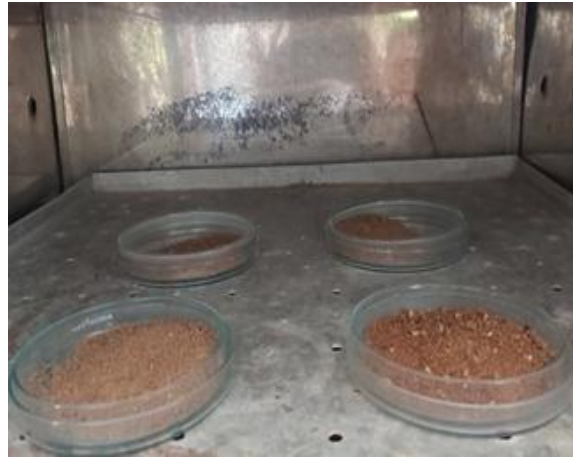


Fig 4.7: Petri dishes in oven for drying

According to AOAC, the standard moisture content for the cookies is below 5%. The moisture content obtained for the prepared multigrains were 3.673%, 3.419%, 3.774% and 3.391%. The moisture content obtained for multigrain cookies were within the standard. For all the 4 formulations the moisture content obtained was within the standard.

**4.3 Total Ash content**

Total ash was carried out in muffle furnace where the crucibles with sample were ignited for 4 hours in the muffle furnace at 550°C. after 4 hours the crucibles were taken out and noted down the W3 weight. The total ash content was calculated by using the formula. The total ash of the cookies were given the below table.

Table 4.6: Total ash content of the multigrain cookies of all the 4 formulations

SL. No	Formulations	Total ash (%)
1	C1	0.869
2	C2	0.914
3	C3	0.876
4	C4	0.946

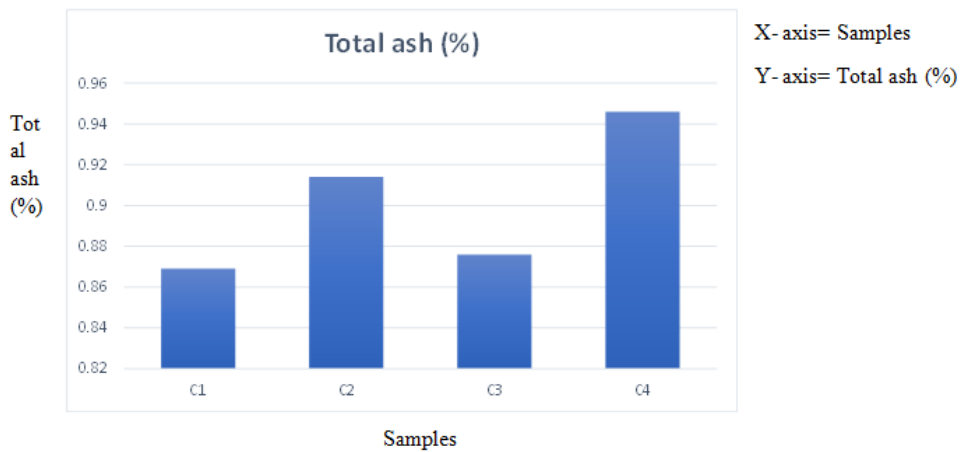


Fig 4.8: Graphical representation of Total ash content



Fig 4.9: Ash formed after ignition

According to AOAC, the standard total ash for cookies is 1% maximum. The total ash for the multigrain cookies obtained were 0.869%, 0.914%, 0.876% and 0.946%. The total ash of the multigrain cookies were within the standard. For all the 4 formulations the total ash were within the standard.

#### 4.4 Acid Insoluble Ash

Acid insoluble ash is the continuous procedue of total ash. After compltion of 4 hours of the total ash procedure, the W3 weight was noted and calculated for total ash. To the W3 crucible dilute HCl was added and the ash is dissolved, that is filtered through a ashless filter paper and ignited again for 4 hours in muffle furnace. After 4 hours the crucible is taken out and was weighed, it is considered as W4. Then acis insoluble ash is calculated by using the formula. The acis insoluble ash of the multigrain cookies were given in the below table.

Table4.7: Acid insoluble ash of multigrain cookies of all the 4 formulations

SL. No	Formulations	Acid insoluble ash (%)
1	C1	0.071
2	C2	0.085
3	C3	0.089
4	C4	0.091

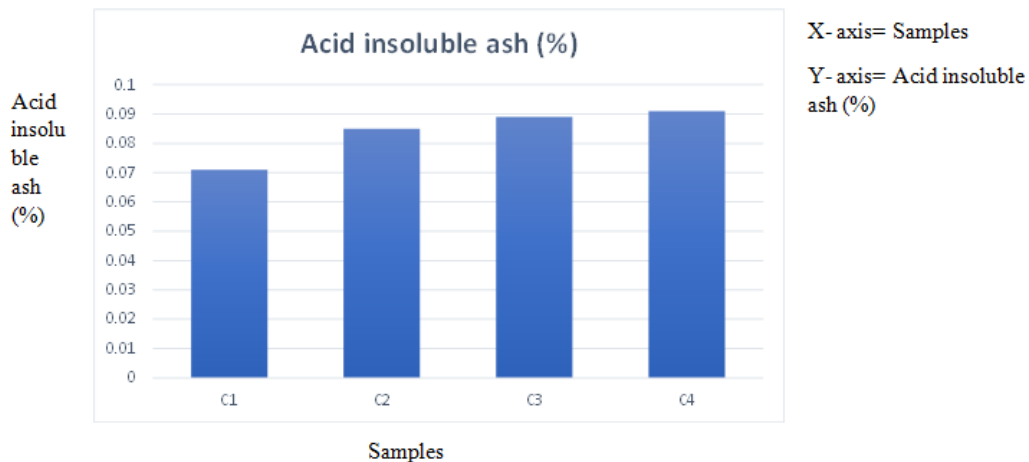


Fig 4.10: Graphical representation of Acid insoluble ash content



Fig 4.11: Ash after the ignition

According to AOAC, the standard acid insoluble ash for cookies is 0.1%. The acid insoluble ash for multigrain cookies obtained were 0.071%, 0.085%, 0.089% and 0.091%. The acidinsoluble ash of the multigrain cookies were obtained within the standard.For all the 4 formulation the acid insoluble ash were within the standard.

#### 4.5 Fat content

The fat content was carried out through sexhlet method. The fat was expressed in the form of percentage. The fat was calculated using the formula. The fat content of the multigrain cookies were given below in the table.

Table4.8: Fat content of the multigrain cookies of all the 4 formulations

SL. No	Formulations	Fat (%)
1	C1	7.217
2	C2	9.314
3	C3	8.327
4	C4	9.271

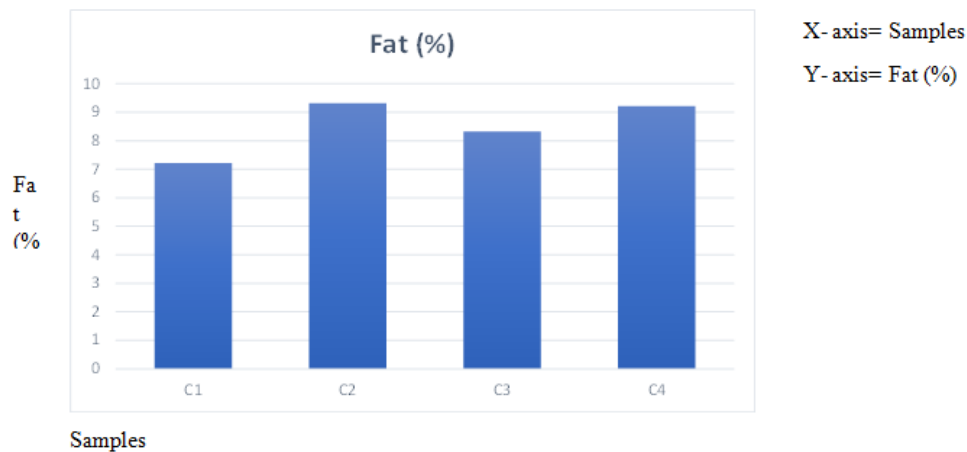


Fig 4.12: Graphical representation of Fat content



Fig 4.13: Fat obtained after soxhlet process

The total fat obtained were 7.217%, 9.314%, 8.327% and 9.271%. The standard fat percentage of cookies according to AOAC ranges between 20-70%. As in this study, the fat was added in cookies was less. So the fat content obtained for multigrain cookies ranges between 7 to 9%.

**4.6 Acidity of extracted fat**

Acidity of extracted fat is the continuous procedure of the fat. The fat extracted by the soxhlet procedure is taken for the acidity of extracted fat. To the extracted fat ethanol and phenopthein indicator were added. It is titrated against NaOH. The burette reading is noted down. The acidity of extracted fat is calculated by using formula. The acidity of extracted fat of multigrain cookies is given below in the table.

Table4.9: Acidity of extracted fat of the multigrain cookis of all the 4 formulations

SL. No	Formulations	Acidity of extracted fat (%)
1	C1	1.108
2	C2	1.205
3	C3	1.22
4	C4	0.970

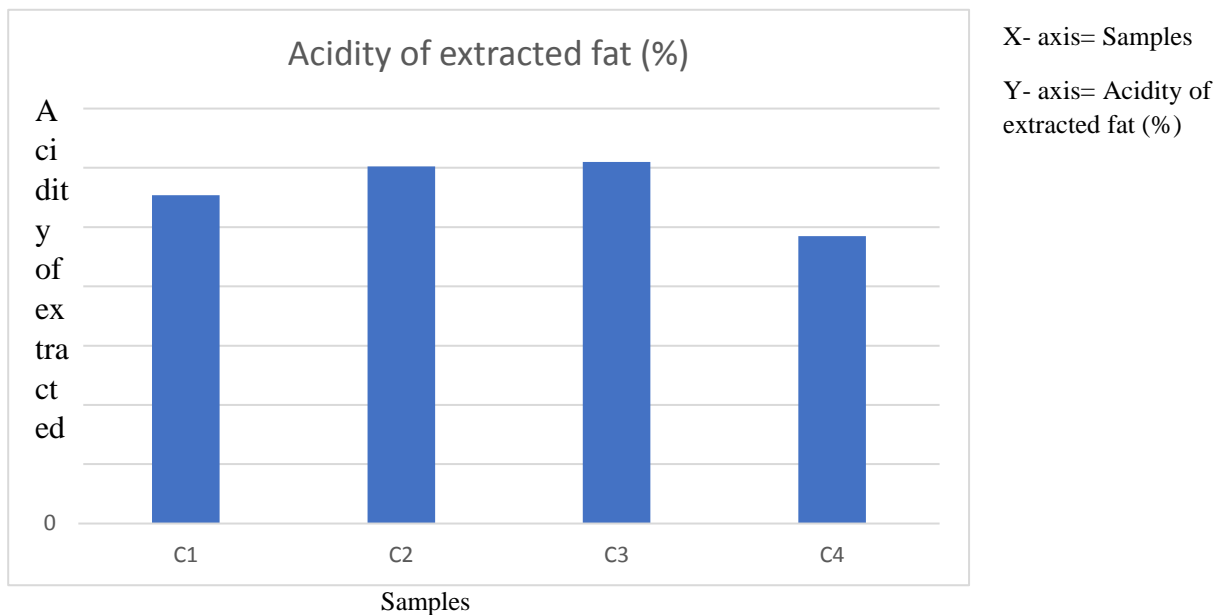


Fig 4.14: Graphical representation of Acidity of extracted fat



Fig 4.15: Titration for acidity of extracted fat

The acidity of extracted fat obtained were 1.108%, 1.205%, 1.22% and 0.970%. the standard Acidity of extracted fat cookies is 1.50% maximum. If it exceeds the standard, the cookies are not fit to consume. The AOAC standard for acidity of extracted fat is 1.50%. The acidity of extracted fat obtained for multigrain cookies were within the standard. For all the 4 formulations the acidity of extracted fat were obtained within the standard.

#### 4.7 Protein content

The protein estimation was carried out in Kjeldhal apparatus. There are 3 steps in Kjeldhal method which included digestion, distillation and titration . in the digestion process the polypeptide bonds are broken together and convert them into simpler chemicals such as carbon dioxide, water and ammonia. Here, the nitrogen in the sample is completely converted into nonvolatile ammonium sulphate. At the end of digestion process, it converts into ocean blue color, indicating the completion of digestion process. In distillation process, sodium hydroxide is added to convert the ammonium salt to ammonia and the color changes to brown color. After the completion of distillation process the colour changes to transparent. In the last proces that is titarion, it is titated against concentrated HCl with methyl red indicator. The end point point of the reaction is pink colour. The amount of HCl consumed to convert it into pink colour is noted down. The protein content of the multigrain cookies is given in the below table.

Table4.10: Protein content of the multigrain cookies of all the formulations

SL. No	Formulations	Nitrogen (%)	Protein (%)
1	C1	1.843	11.518
2	C2	1.849	11.556
3	C3	2.215	13.840
4	C4	2.181	13.631

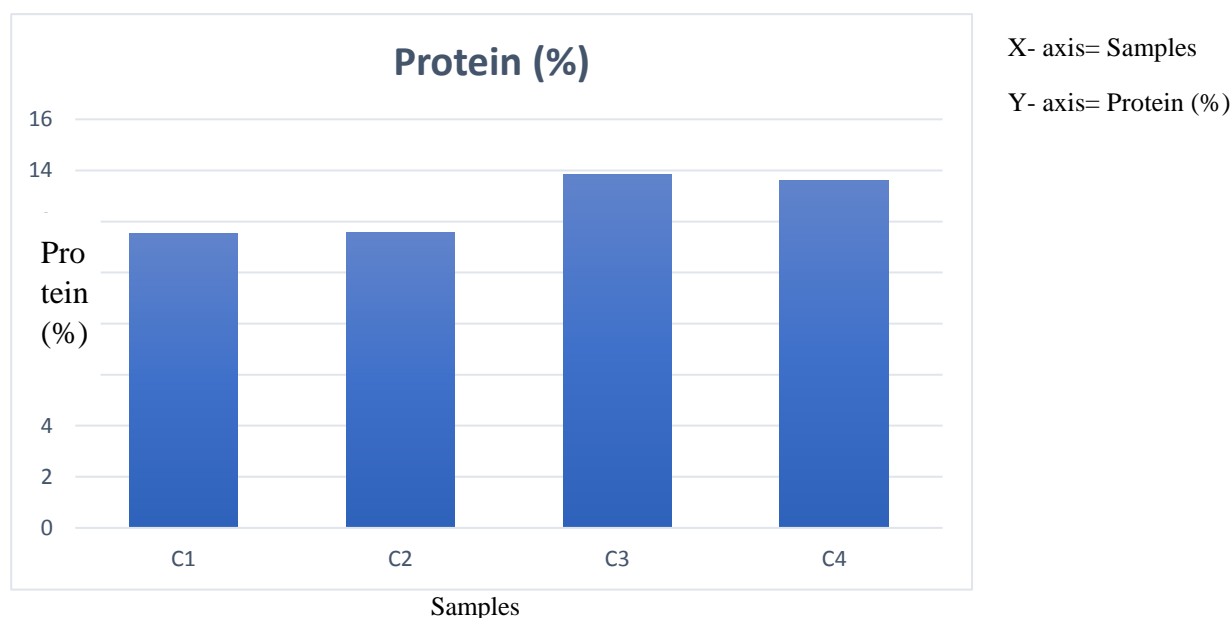


Fig 4.16: Graphical representation of Protein content





Fig 4.17: Digestion process



Fig 4.18: Distillation process



Fig 4.19: Titration process

The protein content for the multigrain cookies obtained were 11.518%, 11.556%, 13.840% and 13. From the referred paper 27, they have obtained 10.77% of protein content. In thus study, the multigrain cookies protein content is higher than [27]. The protein content varies from 11% to 13.6%. There is no standard protein content set by the AOAC or FSSAI. The protein content usually varies depending upon the raw ingredients they have selected for the preparation of the cookies.

#### 4.8 Carbohydrate Content

The carbohydrate estimation was carried out through phenol-sulphuric method, where the glucose was used as a standard. The carbohydrate content of the multigrain cookies is given in the below table.

Table 4.11: Carbohydrate content of the multigrain cookies of all the formulations

SL. No	Formulations	Carbohydrate (%)
1	C1	70.211
2	C2	73.544
3	C3	67.988
4	C4	72.433

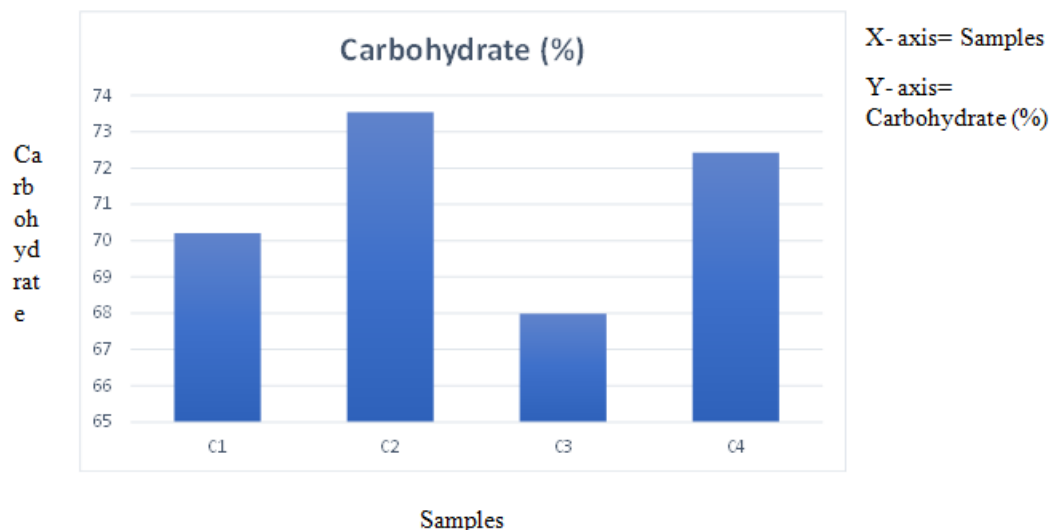


Fig 4.20: Graphical representation of Carbohydrate content

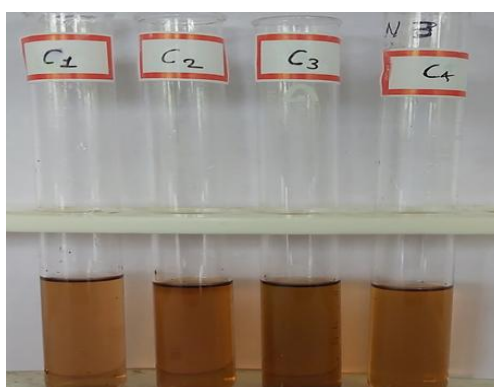


Fig 4.21: Test samples

The carbohydrate percentage for the multigrain cookies obtained were 70.211%, 73.544%, 67.988 and 72.433%. From the literature of review, it is seen that carbohydrate ranges between 57% to 83%. From this study, the obtained carbohydrate content ranges between 57% to 83%. There is no standard carbohydrate content set by the AOAC or FSSAI. The carbohydrate content of the cookies varies according to the flour used.

## V. CONCLUSION

Multigrain cookies were developed with four different formulations by varying the quantities of wheat flour, finger millet flour and oats flour where other ingredients were kept constant. Additionally, chia seeds were added as it is rich in fibre. The different formulations of multigrain cookies were coded as C1, C2, C3 and C4. After developing the multigrain cookies, sensory evaluation was carried out with 15 panelists. 5-scale hedonic rating method was used for sensory evaluation. Among the four formulations C2 and C4 samples were liked by majority of the panelists. Proximate analysis was carried out for the four formulations, where the moisture content ranges between 3.3 to 3.7%, total ash ranges between 0.86-0.95%, acid insoluble ash ranges between 0.07 -0.09%, fat content ranges between 7.2-9.3%, acidity of extracted fat ranges between 0.9-1.22%, protein ranges between 11.5-13.8% and carbohydrate ranges between 67- 78.4%. Shelf-life studies were carried out for 30 days where the parameters such as moisture and acidity of extracted fat were within the standard specifications even at the end of the shelf-life studies. The present study concluded that the multigrain cookies were nutritionally rich and can be stored for 30 days.

## FUTURE PROSPECT

In the further phase of the project, the nutritional content of the multigrain cookies can be increased by incorporating the nutritional rich ingredients. Nowadays the cookies demand is more in the market, so the fortification of cookies can be easily accepted by the consumers. Multigrain cookies can be produced in large scale by optimising the process. To increase the market in future, other multigrain products can also be produced such as multigrain noodles, breads.

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