



Standardization and shelf life study on allergen free millet biscuits using natural preservatives

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Abstract

In developing countries like India with increasing urbanization, the demand for processed food is increasing popularly. Among them, bakery products particularly biscuits command wide popularity in both urban and rural mass. But bakery products like bread, cakes, and biscuits are made with wheat especially maida flour. Wheat contains gluten and gliadin protein. That protein affected our human body and producing allergens. Hence, an attempt was made to develop allergen free millets biscuits (without wheat flour) using spices (natural preservatives) with acceptable sensory attributes. The millets like barnyard, foxtail, finger, little and kodo millets were selected as they contain higher level of nutrients and free from gluten. Spices like garlic, cinnamon and cloves were selected because of their antimicrobial and antioxidant properties. The biscuits are prepared from multigrain with 20% of every millet variety. Spices like garlic, cinnamon and cloves were added at different percentage such as 4%, 2% and 2% respectively. Nutritional content of the millet biscuits are greater than control with same physical characteristics. Shelf life of the spices added millet biscuits higher than the control. Shelf life of the millet biscuits was 45 days and control was 30 days.

Keywords: allergen free, millets, natural preservatives, nutritional composition

Introduction

The word biscuit derives from panis biscoctus which is Latin word for twice-cooked bread and refers to bread rusks. Biscuits are staple foods, snacks, luxury gifts, dietary products, infant foods, and with additions of chocolate and cream, etc. Biscuits have low moisture content and thereby long shelf life if protected from moisture and oxygen in the atmosphere. They are the original 'convenience' manufactured food. The dough pieces were baked and then dried out in another, cooler, oven (Duncan Manley, 1982).

Biscuits defined as products are cereal based and baked to moisture content of less than that 5% (Lakshmi J, 2012). The country's requirement of biscuit is met through local production and import. The present (2012) demand for biscuit is estimated at 1.02 million tons. The demand for the product is projected to reach 1.15 million tons and 1.32 million tons by the years 2017 and 2022, respectively.

The domestic biscuits production which was 4,925 tons at the beginning of the period (2001-02) has grown to 193,773 tons by the end of the period (2009-10). Domestic biscuits production has also exhibited a consistent rising pattern during 2001/02 - 2009/10 period with the exception of year 2008/09 (average growth rate of 130%).

Ingredients for Biscuits

The main ingredients used in making biscuits are Flour, sugar and fat

Flour: It is Main bulk to the biscuits. The gluten in the flour forms the main structure by trapping air and setting when heated. Although biscuits are usually made with plain flour; raising agents may be added to give them a lighter texture. Raising agents (baking powder – sodium bi carbonate) react when they come in contact with water and produce carbon

dioxide bubbles that make the cookie rise during baking.

Sugar: It is sweetens flavour of biscuit mixture. Helps brown the outside layer as it caramelises. Increases bulk of Mixture. When creamed with fat, sugar helps to hold air, acts as a raising agent which is useful more in cake making than biscuit making.

Fat: It gives biscuits their golden colour. It gives biscuits their rich flavour. Butter gives a richer flavour. Butter and soft margarine creams easily with the sugar. Entangles and holds air bubbles in the mixture as creamed with sugar. Helps keep food products moist and extend the biscuits shelf life.

Dough Mixing Method

In bakery industry, different types of dough mixing method are used. They are Melting Method, Rubbing in Method, Creaming Method, Whisking Method and all-in-one method. In this project, All-in-one method is used

Food Allergen

The food allergen labelling requirements were initiated with the Food Allergen Labelling and Consumer Protection Act of 2004 (FALCPA). An allergic reaction to food involves two components of the immune system. One component is a type of protein, an allergy antibody called immunoglobulin E (IgE), which circulates through the blood. The other is the mast cell, a specialized cell that stores up histamine and is found in areas of the body that are typically involved in allergic reactions, including the nose and throat, lungs, skin, and gastrointestinal tract.

The major eight food allergens

Table 1

S. No	Common name of allergen source	Some foods derived from the Allergen Source
1.	Milk	Casein, caseinate, curds, lactalbumin, nougat, rennet casein, whey
2.	Eggs	Albumin, eggnog, meringue
3.	Fish: Common specific name, e.g., bass, flounder, or cod	Surimi
4.	Crustacea (shellfish): Common specific name; e.g., crab, lobster, or shrimp	Crab, lobster, shrimp
5.	Tree Nuts: Common specific name; e.g., almonds, pecans, or walnuts	Almonds, Brazil nuts, cashews, hazelnuts (filberts), pecans, pine nuts, pistachios, macadamia, walnuts
6.	Wheat	Wheat Bran, bulgur, couscous, durum, farina, gluten, matzoh, kamut semolina
7.	Peanuts	Beer nuts, goobers, peanut flour, nutmeal
8.	Soybeans	Hydrolyzed soy protein, miso, TVP, textured soy protein

During recent years there has been a slow and steady increase in consumer interest for wheat (*Triticum aestivum*) free foods for minimizing the risk of relatively unfamiliar condition known as celiac disease (CD). The celiac disease in susceptible people is gluten induced or sensitive entropy characterized by damage of small intestinal mucosa caused by gliadin fraction of wheat. These researchers suggested that the celiac disease can be treated by avoiding of gluten ingestion. Gluten is known as "heart and soul" of bakery for providing the processing qualities familiar to both the home baker as well as the commercial food manufacturer. Since gluten plays a limited role in defining the process ability and end product quality of cookies, it can be complemented through some alternate flours in various combinations

Millets

The term "Millets" refers to any of the small-seeded cereal and forage grasses used for food, feed or forage. In earlier times sorghum and even maize were included in this category. Synonyms like "miscellaneous cereals" or "Coarse grains" are also used to describe the millets. There are about 6,000 varieties of millet throughout the world with grains varying in colour from pale yellow, to gray, white, and red. Archaeologists say that foxtail millet is so old that no wild plant of the species is known to exist today.

Types of Millets Used

Finger millet or Ragi (*Eleusine coracana* Gaertn): It is a short, profusely tillering plant with characteristic finger like terminal inflorescences, bearing small reddish seeds. Finger millet is frequently an important constituent in local beer making. Sometimes it is the major constituent, but frequently it is added to sorghum and other carbohydrate sources. The finger millet enzyme is reported to have a saccharifying power greater than the corresponding enzymes from sorghum or maize malt, but less than that of barley malt amylases. Ragi contains high amount of calcium, protein with well-balanced essential amino acids composition along with Vitamin A, Vitamin B and phosphorous. It also contains high amount of calcium. Ragi flour in Karnataka is mostly prepared into ragi balls, popularly known as ragi mudde, made into flatbreads, leavened dosa and thinner, unleavened rotis. Its high fiber content also checks constipation, high blood cholesterol and intestinal cancer.

Foxtail millet or Thinai (*Set aria italica* Beauv): It is a gluten free grain is and the second most commonly grown species. It is one of the oldest cultivated millet. Generally grown in semi-arid regions, it has a low water requirement,

though it does not recover well from drought conditions because it has a shallow root system. Foxtail millet, considered a crop for poor people, is grown mainly in China, Bangladesh and India. It requires warm weather and matures quickly in the hot summer months. Practically devoid of grain storage pest, foxtail millet has a long storage life. Foxtail millet has many nutritious and medical functions. Foxtail millet is non-glutinous, like buckwheat and quinoa, and it is not an acid forming food, so it is soothing and easy to digest. In fact, it is considered to be one of the least allergenic and most digestible grains available and it is a warming grain.

Kodo millet or Varagu (*Paspalum scrobiculatum* Linn):

It was domesticated in India almost 3000 years ago. It is found across the old world in humid habitats of tropics and subtropics. It is a minor grain crop in India, and an important crop in the Deccan plateau. Its cultivation in India is generally confined to Gujarat, Karnataka and parts of Tamil Nadu. The grain may vary in colour from light red to dark grey. The fibre content of the whole grain is very high. As with other food grains, the nutritive value of Kodo millet protein could be improved by supplementation with legume protein.

Little millet or Samai (*Panicum miliare* Lam): It is mostly mix cropped with other millets, pulses and oilseeds. The seeds of little millet are smaller than those of common millet. It is generally consumed as rice and any recipe that demands staple rice can be prepared using little millet. One such traditional group of cereal crops is the little millets. It has nutritionally superior to rice and wheat, provide cheap proteins, minerals and vitamins. Practically devoid of grain storage pests, the little millets have indefinite storage life. Little millets have high nutritional and medicinal value, high dietary fibre content, easy digestibility and other uses. It has medicinal values in the management of diabetes and lowering lipids esp. cholesterol. Best remedy for obese, diabetic, elders and flat belly aspirants.

Barnyard millet or Kuthirai vali (*Echinochloa frumentacea*): The two species under genus *Echinochloa*, *E. frumentacea* (Indian barnyard millet) and *E. esculenta* (Japanese barnyard millet), are cultivated for food and fodder by hilly and tribal communities in Asia particularly in India, China and Japan. It is an important minor millet having fair amounts of protein (12%) that is highly digestible (81.13%) coupled with low carbohydrate content (58.56%) of slow digestibility ie., 25.88%. The dietary fiber is an important phytochemical component of barnyard millet

(13% total dietary fiber with 4.66 and 8.18% of soluble and insoluble fractions, respectively) that could be considered in the management of disorders like diabetes mellitus, obesity, hyperlipidemia, etc.

Apreservatives

A preservative is a substance that is added to products such as foods, pharmaceuticals, biological samples, wood and etc. to prevent decomposition by microbial growth or by undesirable chemical changes. General preservation is implemented by two modes, chemical and physical. Chemical preservation entails adding chemical compounds to the product. Physical preservation entails refrigeration and freezing.

Preservatives are classified into two types. They are,

1. Class I preservative or Natural preservatives

Examples: salt, sugar, smoke, vinegar, oils, spices and etc.

2. Class II preservative or chemical preservatives

Examples: sodium benzoate, sodium alginate, sulphates, nitrates, nitrites and etc.

Commonly any preservative required mainly antimicrobial and antioxidant properties.

Antimicrobial additives: Antimicrobial preservatives prevent degradation by bacteria. This method is the most traditional and ancient type of preserving. The ancient methods such as pickling and adding honey prevent microorganism growth by modifying the pH level. The most commonly used antimicrobial preservatives are sodium benzoate, benzoic acid, nitrate, nitrites and lactic acid.

Antioxidants: The oxidation process spoils most food, especially those with a high fat content. Fats quickly turn rancid when exposed to oxygen. Antioxidants prevent or inhibit the oxidation process. The most common antioxidant additives are ascorbic acids, ascorbates, and BHA, BHT and propyl gallate.

Spices

Spices have been used as food additives since ancient times, as flavouring agents but also as natural food preservatives. A number of spices show antimicrobial activity against different types of microorganisms. At ancient times, spices have been added to food, not only as flavouring agents but also as preservatives. Spices are defined as "any dried, fragrant, aromatic, or pungent vegetable or plant substance, in the whole, broken, or ground form, that contributes flavour, whose primary function in food is seasoning rather than nutrition, and that may contribute relish or piquancy to foods or beverages. Spices have been prescribed for aiding digestion, decreasing blood pressure, controlling metabolism, and delaying the onset of degenerative diseases.

- Spices inhibit or kill bacteria and fungi that either spoil food or harm humans
- Spices provide macro or micronutrients
- Spices enhance the evaporative cooling
- Spices disguise the taste of spoiled food
- Spices added flavour and taste to the food

Cinnamon (*Cinnamomum verum J. Presl*)

Cinnamon is one of the finest sweet spices, with cassia as a coarser substitute. The botanical name *Cinnamomum* is derived from the Hebraic and Arabic term amomon, meaning fragrant spice plant. Both cinnamon and cassia were popular spices in Greece and Rome. Cinnamon's name is derived from the Greek word, kinamon. Cinnamon bark contains essential oil (up to 2%), with cinnamaldehyde (60–80%) as the major constituent. Cinnamoldehyde is a principle compound of cinnamon. It is used to improve the flavour of other non-medicinal products. In folk medicine it is used to treat colds, nausea, inflammation, rheumatism, vomiting, and menstrual disorders. It has carminative and astringent properties. Cinnamon has anti-inflammatory, antimicrobial, antibacterial, antioxidant, antitumor, cardiovascular, cholesterol-lowering, and immune modulator effects.

Clove (*Syzygium aromaticum (L.) Merr. and L. M. Perry*)

In the Moluccas, where cloves were first found, parents planted a clove tree when a child was born. It is first recorded in the Chinese Han period (220–206 BC). The name clove is derived from the French word clou and Spanish clavo, both meaning "nail," because of its resemblance to the shape of a nail. Clove buds contain essential oil (15–20%), protein 6%, lipids 20%, and carbohydrates 61%, vitamins. The major constituents of the oil are eugenol (up to 85%), eugenyl acetate (up to 15%), and β -caryophyllene (up to 8%). Eugenol is the principle compound of cloves. Clove has known antifungal, antiseptic, anesthetic, antispasmodic, and carminative activity. It has been reported to aid digestion, stomach disorders, and pain relief. In addition to its antimicrobial, acaricidal, antifungal, antiviral, antiulcer, and antioxidant activity, clove essential oil has been shown to possess anti-inflammatory, cytotoxic, insect repellent, and anesthetic properties.

Garlic (*Allium sativum L.*)

The common name garlic describes the leaves and use, taken from the Anglo-Saxon gar (lance) and leac (leek, or pot-herb). Garlic has been grown and used as a medicinal since ancient times. The Indians, Chinese, Sumerians, and ancient Egyptians consumed garlic over 4,000 years ago.

Garlic has been used as a carminative, nerve tonic, and antiseptic agent, for treating coughs, chronic bronchitis, toothache, earache, dandruff, high blood pressure, arteriosclerosis, hysteria, and cancers. Garlic cloves, teas, and syrups have been used as an aphrodisiac, to treat fever, flu symptoms, and shortness of breath, sinus congestion, headache, stomachache, hypertension, gout, rheumatism, pinworms, old ulcers, and snakebites

Materials and Methods

Flour Preparation

Five millets (kodo, finger, foxtail, barnyard and little millets) collected from local market and make it into flour. Millets are dried, cleaned (remove dust particles) and fried into 60°C for 10 minutes (color change into light brown) and then milled and make it flour (size 0.16mm).

Millets

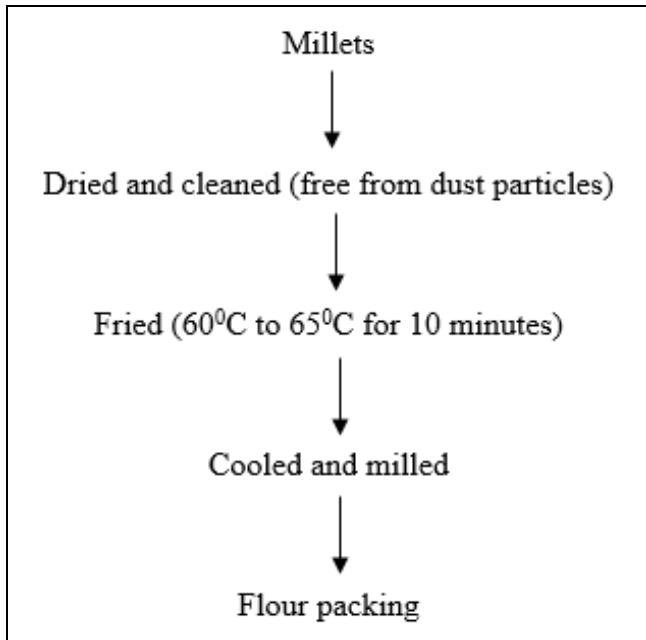


Fig 1

Preparation of spices powder

Garlic cloves are separated, peeling (remove outer white layer), cleaning (free from dust), dried at $110 \pm 5^\circ\text{C}$ for 3 to 4 hours. After drying make it into powder form. Cloves and cinnamon are available at dried forms in market. Collected, cleaned, and make it into powder.

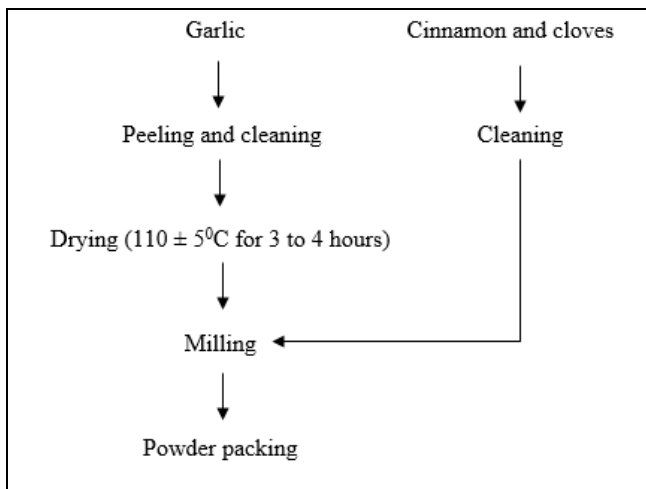


Fig 2

Preparation of Biscuit

Ingredients

- Millet flour - 100 g
- Icing sugar - 30 g
- Vanaspathi - 40 g
- Liquid glucose - 8 g
- Cinnamon - 2 g (or)
- Cloves powder - 2 g (or)
- Garlic powder - 4 g

Biscuit making by creaming method

Icing sugar and fat are mixed together. Then all dried ingredients mixed separately and then mixed with mixture of icing sugar. Make it into a dough, sheeting, molding, baking ($180 \pm 3^\circ\text{C}$ for 20 minutes), cooling and then packing.

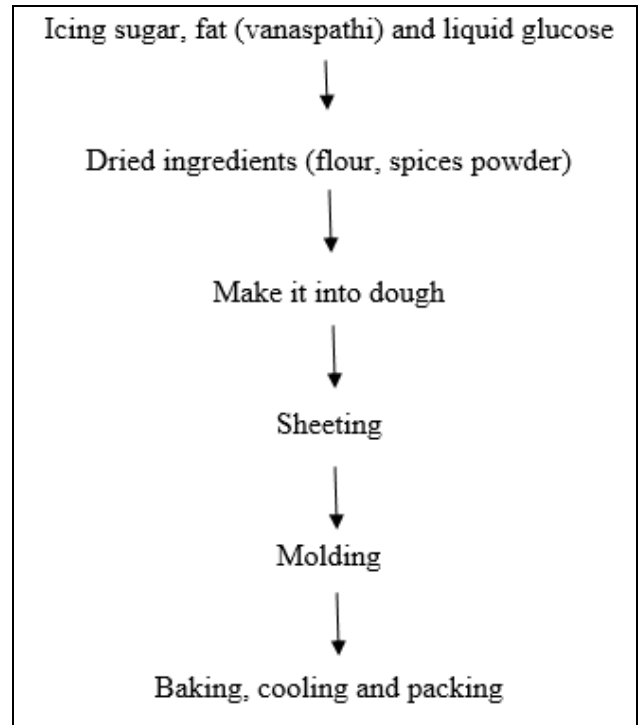


Fig 3

Results and Discussion

Quality analysis for raw Material

Commonly in any food product manufacturing, raw material quality is very important. That's only giving quality to the final goods. Like that in biscuit, flour is main bulk to the product. The flour should not contain more than 5% moisture content. Because moisture content is important source for the growth of microorganism as well as high moisture content affect the sensory character of the biscuit. And also natural preservative (spices powder) also having some limits on their moisture content. In this project, all raw materials are high quality and quality parameters within limit. Gluten content is a major allergen in wheat and wheat products. That gluten protein is affecting the human stomach (intestinal) part at regular basis of consumption of wheat and wheat products. But in this study, 100% millet flour was used without wheat flour. Wheat flour contains 9.9% gluten content. Maida contains 12.2% gluten content, maida containing comparatively more gluten than wheat flour. But millet contains 0% gluten content. Raw materials free from allergen and final goods not containing gluten content. Gluten content can cause constipation in human beings. But millet biscuits without gluten will not cause constipation.

Quality test for final biscuits

As per Indian Standards (IS), moisture, acid insoluble ash and acidity of extracted fat are most important quality parameters for biscuits. These three parameters only used for biscuit shelf life estimation. As per Indian standards, moisture having below 5%, acid insoluble ash below 0.1%, acidity of extracted fat has below 1.5%. Acid insoluble ash determines the any insoluble heavy metals present in the product like chemical additives and etc. Acid insoluble ash was not present in final goods. Acidity of extracted fat was increased by storage days increased. So this is used as a main parameter for shelf life study. Acidity was indirectly indicating microbial growth also.

Physical test evaluation for final biscuits:

Physical characters of biscuits are determined by the size, shape and texture of the product. Bulk density is the best indication of good baking quality. Density and thickness of the millet biscuit was higher than control biscuits. Diameter, spread ratio and spread factor has lower value than control. Excessive starch damage during milling of millets caused deleterious effect on the spread ratio of biscuits. Baking quality of millet biscuits is better than maida biscuit. Mass and volume indicating yield of the product. They both are higher than control biscuits. Physical characters of millet biscuits are much better than maida biscuit.

Microbiological Studies

- TPC limit – 50000/g
- Yeast & Mold limit – 10/g

Preservatives inhibit or slow down the microbial growth. In this project, natural preservatives like garlic, cinnamon and cloves are used. All these three having antimicrobial and antifungal properties. Spices added biscuits having higher shelf life than the control one. In table.6 showing, both garlic and cinnamon has nearby same effects in TPC. Cloves have more effects than another two. In table.7 showing, garlic having more effects on yeast and mould than the two. Spices flavored biscuits having 45 days at room temperature and without spices biscuits have 30 days at room temperature.

Nutritional content of the final products

Nutritional composition like protein, fat, fibre, ash, carbohydrate, minerals and vitamins are very important for all food products as it is providing growth and strength to the humans. Nutritional composition of millet biscuits were compared with control (maida) biscuit. Millet biscuit contains high nutritional content than control biscuit. Garlic biscuit contains high level of protein, Iron and calcium. Cinnamon biscuit contains more fibre content than other variety.

Cloves biscuit contains high fat and ash then other variety. Likewise all flavoured millet biscuits contain high nutritional than maida biscuit (control).

Sensory evaluation of the final flavored millet biscuits

Sensory evaluation is a scientific discipline used to evoke measure, analyze and interpret reactions to the characteristics of food and materials as they are perceived by the senses of sight, smell, taste, touch and hearing. In all food products evaluating the sensory quality of the final product is most important. Here using five point hedonic scales, the sensory quality was estimated. Those five scales are flavour, colour, texture, taste and overall acceptability. This study has three different flavoured biscuit, but all the three types are prepared by using same base mix except flavour variance. Thereby, all types having same colour and texture.

But flavour and taste are differed as well as nutritional component also changed depend upon the additional of

Flavour components like cinnamon, garlic and cloves. In these varieties, garlic and cinnamon variety has scored high at flavour, taste and overall acceptability.

Tables and Figures

Table 1: Quality analysis for raw material:

Moisture analysis for millets	
Barnyard millet	4.1 ± 0.14
Finger millet	4.4 ± 0.09
Kodo millet	3.9 ± 0.12
Little millet	4.0 ± 0.21
Foxtail millet	4.1 ± 0.24
Moisture analysis for spices	
Garlic powder	4.2 ± 0.18
Cinnamon powder	4.5 ± 0.11
Cloves powder	10.3 ± 0.17
Gluten analysis for flour	
Wheat flour	9.9 ± 0.1
Maida flour	12.2 ± 0.2
Millet flour mix	0

Table 2: Quality test for final biscuits:

Biscuits	Moisture		Acid insoluble ash		Acidity of extracted fat	
	0 th day	45 th day	0 th day	45 th day	0 th day	45 th day
Garlic	1.4 ± 0.16	1.7 ± 0.14	Nil	Nil	0.08 ± 0.01	0.5 ± 0.01
Cinnamon	1.4 ± 0.14	1.5 ± 0.14	Nil	Nil	0.1 ± 0.01	0.7 ± 0.01
Cloves	1.7 ± 0.11	1.9 ± 0.13	Nil	Nil	0.1 ± 0.03	0.8 ± 0.02
Control	1.5 ± 0.16	1.8 ± 0.16	Nil	Nil	0.3 ± 0.02	1.2 ± 0.03
Limits	5.0% Max		0.1 % Max		1.5% Max	

Table 3: Physical test evaluation for final biscuits:

Parameters	Control (Maida)	Garlic biscuit	Cinnamon biscuit	Cloves Biscuit
Diameter (cm)	4.3	4.2	4.2	4.2
Thickness (cm)	0.65	0.69	0.69	0.69
Mass (g)	8.345	8.340	8.338	8.341
Volume (cm ³)	9.4	9.6	9.6	9.6
Density (g/cm ³)	0.84	0.86	0.87	0.87
Spread ratio	6.6	6.08	6.08	6.08
Spread factor	100%	92%	92%	92%

Microbiological Studies

Table 4: Microbiological test for biscuits:

	Total plate count (Cfu/g)				
	0 th	15 th	30 th	45 th	60 th
Plain millet biscuit	9.32 ± 0.5	29.7 ± 0.45	48.4 ± 0.46	>50	>50
Garlic biscuit	4.37 ± 0.18	8.71 ± 0.42	20.6 ± 0.44	44.4 ± 0.16	>50
Cinnamon biscuit	4.12 ± 0.22	8.56 ± 0.45	21.0 ± 0.43	46.9 ± 0.24	>50
Cloves biscuit	3.84 ± 0.30	7.43 ± 0.45	19.7 ± 0.65	47.1 ± 0.35	>50
	Yeast & Mold (Cfu/g)				
Plain millet biscuit	A	3.52 ± 0.34	6.75 ± 0.42	> 10	> 10
Garlic biscuit	A	A	2.9 ± 0.27	6.45 ± 0.29	> 10
Cinnamon biscuit	A	A	4.11 ± 0.54	7.36 ± 0.37	> 10
Cloves biscuit	A	A	4.56 ± 0.32	6.89 ± 0.34	> 10

- TPC limit – 50000/g
- Yeast & Mold limit – 10/g

Table 5: Nutritional content of the final products:

Parameters	Control (maida biscuit)	Garlic biscuit	Cinnamon biscuit	Cloves biscuit
Proximate composition				
Protein (g/100g)	8.2 ± 1	10.3 ± 1	9.38 ± 1	9.4 ± 1
Fat (g/100g)	1.8 ± 1	3.4 ± 1	3.5 ± 1	3.9 ± 1
Fiber (g/100g)	0.8 ± 0.05	4.7 ± 1	5.1 ± 1	4.9 ± 1
Ash (g/100g)	0.6 ± 0.05	0.8 ± 0.05	0.8 ± 0.05	0.9 ± 0.05
Carbohydrate (g/100g)	88.1 ± 2	78.3 ± 2	78.6 ± 2	77.5 ± 2
Energy (kcal/100g)	392 ± 2	397 ± 2	396 ± 2	398 ± 2
Minerals				
Iron (mg/100g)	3.3 ± 0.05	6.3 ± 0.05	6.1 ± 0.05	5.2 ± 0.05
Calcium (mg/100g)	42 ± 0.05	103 ± 0.05	96 ± 0.05	89 ± 0.05

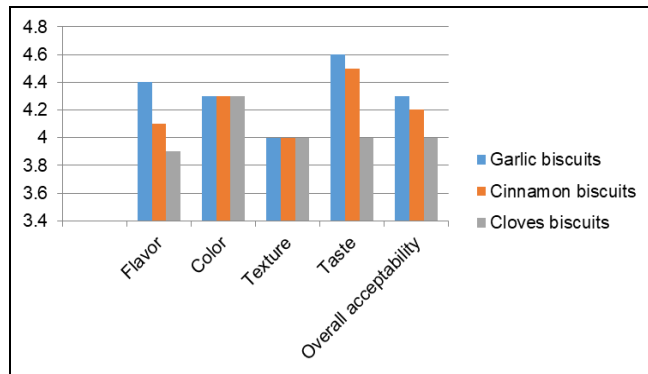


Fig 4: Sensory evaluation of the final flavored millet biscuits:

Conclusion

Millet is a primitive product, millet usage has decreased day by day. But they are good for health. Some people have aversion to eat that millet rice. So we use millet in ready to eat food products. Millet biscuits are free from allergen. All kind and age group of people are consuming millet biscuits. Commonly all food manufacturing industry used chemical preservatives for increasing shelf life of the product. But in this study, I used natural preservatives like spices powder. Spices powder was used to increase shelflife of the product and also used as a flavor to the product. The cooking quality comprising the physical characteristics for my product was as good as the control. Shelflife of the Plain millet biscuits have 30 days and spices flavored biscuits have 45 days. Millet biscuits are a healthy product. They have high nutritional content like ash, fibre, protein, iron and calcium. Protein, iron and calcium content in garlic flavored biscuits were found to be 10.3g/100g, 6.3mg/100g, and 103mg/100g respectively. Fibre content in cinnamon flavored biscuit was found to be 5.1g/100g. Ash content in cloves flavored biscuit was found to be 0.9/100g. Diabetic patients and constipation patients are consuming millet biscuits as a cure. Millet biscuits have attained good sensory quality by untrained sensory panelist (25 – 60 age groups). Garlic flavored biscuits have scored the maximum in the sensory test. The yield was remarkable around 90% to 95%. Finally millet biscuits are good for health, free from allergen and chemical preservatives.

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