A DISSERTATION ON

Development of Finger Millet Cookies Incorporated with Elephant Foot Yam Powder

SUBMITTED TO THE
DEPARTMENT OF BIOENGINEERING
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IN PARTIAL FULFILMENT
FOR THE
DEGREE OF MASTER OF TECHNOLOGY
IN FOOD TECHNOLOGY

BY
Somiya Khan
B. Tech-M. Tech Dual Degree Food Technology (X Semester)
Roll No: 1801087036

UNDER THE SUPERVISION OF

Dr. Rahul Singh
Assistant Professor
Department of Bioengineering

INTEGRAL UNIVERSITY, DASAULI, KURSI ROAD
LUCKNOW- 226026

<u>DECLARATION FORM</u>

I, **Somiya Khan**, a student of **B.Tech.-M.Tech. Dual Degree Food Technology** (V Year / X Semester), Integral University have completed my six-months dissertation work entitled **“Development of Finger Millet Cookies Incorporated with Elephant Foot Yam Powder”** successfully from **Integral University, Lucknow** under the able guidance of **Dr. Rahul Singh.**

I, hereby, affirm that the work has been done by me in all aspects. I have sincerely prepared this project report and the results reported in this study are genuine and authentic.

Somiya Khan

Dr. Rahul Singh
Assistant Professor
Department of Bioengineering

INTEGRAL UNIVERSITY
LUCKNOW - INDIA
Phone No.: +91(0522) 2890812, 2890730, 3296117, 6451039, Fax No.: 0522-2890809
Kursi Road, Lucknow-226026 Uttar Pradesh (INDIA)

CERTIFICATE

Certificate that Ms.**Somiya Khan** (Enrollment number 1800101326) has carried out the research work presented in this thesis entitled **"Development of Finger Millet Cookies Incorporated with Elephant Foot Yam Powder"** for the award of **B.Tech.-M.Tech. Dual Degree Food Technology** from Integral University, Lucknow under my supervision. The thesis embodies the results of original work and studies carried out by the student himself and the contents of the thesis do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution. The dissertation was a compulsory part of her **B.Tech.-M.Tech. Dual Degree Food Technology** degree.

I wish her good luck and a bright future.

Dr. Rahul Singh
(Supervisor)
Assistant Professor
Department of Bioengineering

INTEGRAL UNIVERSITY
LUCKNOW - INDIA
Phone No.: +91(0522) 2890812, 2890730, 3296117, 6451039, Fax No.: 0522-2890809
Kursi Road, Lucknow-226026 Uttar Pradesh (INDIA)

CERTIFICATE BY INTERNAL ADVISOR

This is to certify that **Somiya Khan,** a student of **B.Tech.-M.Tech. Dual Degree Food Technology** (V Year / X Semester), Integral University has completed her six-month dissertation work entitled **"Development of Finger Millet Cookies Incorporated with Elephant Foot Yam Powder"** successfully. She has completed this work from Integral University under the guidance of Dr. Rahul Singh. The dissertation was a compulsory part of her **B.Tech.-M.Tech. Dual Degree Food Technology** degree.

I wish her good luck and a bright future.

Dr. Rahul Singh
Assistant Professor
Department of Bioengineering
Faculty of Engineering & Information Technology

INTEGRAL UNIVERSITY
LUCKNOW - INDIA
Phone No.: +91(0522) 2890812, 2890730, 3296117, 6451039, Fax No.: 0522-2890809
Kursi Road, Lucknow-226026 Uttar Pradesh (INDIA)

TO WHOM IT MAY CONCERN

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I wish her good luck and a bright future.

Dr.Alvina Farooqui
Professor and Head
Department of Bioengineering
Faculty of Engineering& Information Technology

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Place: Lucknow Somiya Khan

Date:

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ABSTRACT

The fast-growing life of the human population has demanded nutrient-enriched food products Cookies being one of the bakery products generally made up of refined flour which is high in gluten and are high in demand with all classes of people. The present study was undertaken to study the gluten free product in the form of Finger Millet generally known as Ragi and Physico-chemical attributes of its standard sample as well as processed cookies in addition with the quality attributes evaluated by determining the response variable consisting of sensory parameters like flavor, texture, color, appearance, and overall acceptability. To enhance its nutritive value, another gluten free underutilized product that is Elephant Foot Yam (EFY) powder is incorporated with ragi flour to increase its nutrition. The present study aims to address the nutrient enrichment of the ragi cookies by incorporating EFY powder in it. The hypothesis was designed to give value addition to the traditionally cooked cookies by making its protein, iron, vitamin, and calcium enriched.

The result stated that the finger millet cookies incorporated with EFY powder (35:15) showed best moisture content of (0.8%), total ash content of (0.8%), fat content of (1.2%), and protein content of (9.0%) with sensory attributes based on hedonic scale with different parameters having color(7), taste(8), aroma(7), flavor(7), texture(7), appearance(7), and overall acceptability(8). The thickness decreased and spread ratio increased of the finger millet cookies with the incorporation of EFY powder. The study has shown that the value addition Finger Millet can be made in the form of cookies which is nutritionally rich and also can be commercially exploited as compared to cookies generally available in the market.

Keywords: Finger Millet, Elephant Foot Yam, Gluten-free, Nutrient rich

CHAPTER 1

INTRODUCTION

In today's world with urbanization, globalization and economic development a rapid change in the dietary lifestyle has been seen since few years which is leading towards increment in the number of people suffering from poor health, reflected by ascending incidence of diseases such as obesity, diabetes, cardiovascular disease, stroke, hypertension, etc. (Goyal., et al., 2015) Recently an increase in consumer awareness related to the health-enhancing roles of specific foods or physiologically active food components has been observed (Pang., et al., 2012)

Food should prevent nutrition-related diseases and must focus on improving physical and mental well-being of the consumers other than only satisfying hunger and providing nutrients to the humans (Menrad., et al.,2003).

This will lead to the development of new concepts in the area of food and nutrition such as the development of health foods that gives benefit beyond nutrition (Vaughan, et al., 2003).

Health food helps in celiac_disease treatment which includes nutritional therapy (Tapia, et al., 2013). It helps those people who are allergic to gluten (a protein found in grains like wheat, rye, barley and oats) and require avoiding such type of foods (Moreno, et al., 2014). Therefore, specific considerations are important when designing such health food products.

Various factors such as health problems, current demand, cost and acceptability should be taken as a priority concern. Health foods design should focus on the special age groups such as elders, youths and infants. Therefore, an attempt has been made to review all the considerations which play an important role in the development of health foods for celiac patients.

To overcome this problem by preparing gluten-free products brings out a big challenge to the manufacturers of finding suitable alternatives for gluten (Gallagher, et al., 2004). The main component protein have high quantity in the form of gluten; glutenin, and gliadin, which have an important role in baking quality characteristics, and are responsible for water absorption capacity, cohesivity, viscosity, and elasticity of dough (Weiser, et al., 2007). Hence, removal of gluten from bakery products can leads to major problems for bakers in quality aspects (Gallagher, et al., 2004).

Since to overcome these deficiencies, most of the diet gets indulge some unhealthy combinations of gluten free products which for sometimes tends out to be safe but not permanently. Therefore, the best gluten free product can be considered nowadays are millets which can sustain almost all the nutrients as well as can form best products through baking.Now the problem arises to get the best combination with almost same quality with millet that does not put human health at risk and tends out to be great source of gluten free product for human health and leads to natural resource degradation.

To address these issues, we hypothesized the fusion of finger millet and elephant foot yam through new product development, which contains macro and micro nutrients such as protein, calcium, carbohydrates, and so on.

The finger millet (*Eleusine coracana*), commonly known as Ragi, consider to be an indispensible traditional crop. In recent years, because of its nutritional strength in terms of dietary fiber, starch pattern, as well as high calcium and iron content it has gained much importance. Due to urbanization, changing food preferences, non-exposure of grains as well as unavailability of products as per the taste of rural and urban dwellers, the cropped area under finger millet and its consumption has decreased significantly, despite having nutritional and health benefits. Moreover, the promotion of finger millet requires diversification of products in terms of health food, ready to eat foods, bakery products etc. (Sinha et al., 2013).

Finger millets are available in multicolor such as white, tan, red, yellow, brown, and violet. The red colored finger millets are found in Srilanka, Nepal, Madagascar, Malaysia, Uganda, Japan, different parts of Africa and India. Finger millets are cultivated in 25 counties in Asia and Africa and occupy around 12% of the area dedicated for the millet crops. Finger millet is an essential food source in South Karnataka. Although Finger millets have high nutritional benefits, it has thirty times more calcium than rice but it is the less focused and low utilized crops. There is enormous scope to process finger millet into various value-added food products in developing countries, as finger millets do not have gluten and hence it can be used by people with gluten allergy and those who have abdominal problem as well.

Amorphophallus paeoniifoilus known as elephant foot yam is a tropical tuber crop, commonly available throughout India. It is widely used as medicine in the Indian tradition and it contains adequate source of starch, nutrients, minerals and proteins. In general, the corms of *A.*

paeoniifoilus are a delicacy in food and it is commonly used as vegetable in delicious cuisines. *A. paeoniifoilus* tuber contains blood purifier properties and traditionally used for the treatment of abdominal disorders, asthma, dyspnoea, tumors, etc. (Singh et al**.** **2015**). The tuber acts as functional food due to the presence of its starch and resistant starch which consists of numerous physiological health benefits in humans and on diseases like obesity, diabetes and hyperlipidemia (Reddy et al. **2014**).

Since consumption of *A. paeoniifoilus* is not widely practiced, and storage of fresh yam is a difficult process as its deterioration is rapid (Afoakwa, et. al., **2001**). Studies have proved that drying techniques when combined with blanching process shows significantly improved feasibility and viability option in food formulations (Suriya et al. **2016**). The browning reactions due to discoloration happen because of action of polyphenol-oxidase and peroxidase enzymes (Asemota et al. **1992**). Blanching process can prevent browning reaction by enzyme deactivation. Therefore, preservation of *A. paeoniifoilus* can be considered as a vital step in unraveling the nutraceuticals potential of *A. paeoniifoilus*.

In Indian state of West Bengal, Assam, and Bangladesh it is known as *Ol* and is usually eaten as mashed or fried or added to curries and, more rarely used in pickle. In some households, the green leaves and stems are also cooked as green vegetables.In Maharashtra, Uttar Pradesh and Gujarat (Suran), Chhattisgarh (Zimmikanda), Tripura (Batema), Karnataka (Suvarnagadde), Kerala (Chena), Tamil (Kaaraa Karanai Kizangu), Nepal (Ol, Kaan, Suran), Philippines (Pongapong), and so on.Moreover, because of the ill effects on humans it was advocate to consume its composite flour than refined flour as per dietary guidelines (Devi, et. al., **2014**).

As EFY is gluten free product so its flour can surely help with the finger millet flour combination for the production of cookies and will not resist its nutritional benefits.Of all the bakery goods, cookies are thought to be the most important in the world. Both adults and children enjoy these foods as snacks (Hussain et al., 2000). Cookies have a lower moisture content than other baked goods like bread and cakes, which keeps them free of microbial deterioration and gives the product a longer shelf life (Wade, 1988).

Cookies' prolonged lifespans allow bulk production and distribution. They are desirable for fortification and other nutritional improvements due to their good eating quality. A certain amount of fortification is done to achieve the following goals: to maintain the nutritional quality of foods, to maintain adequate nutrient levels to correct or prevent specific nutritional deficiencies in the population or in groups at risk for certain deficiencies, to increase the added nutritional value of a product (from a commercial standpoint), and to provide specific technological functions in food processing (Dukwal, 2004).

Substitution is the process of entirely swapping out one ingredient for another that is appropriate, especially when the original ingredient is an allergy. In the current study, ragi flour is used instead of wheat to make gluten-free ragi cookies. The reason is because gluten, a unique form of protein that is frequently present in rye, wheat, and barley, causes a condition known as celiac disease. (NIDDK, 2008).

The usage of millet flour in baked goods is increasing, particularly in bread, cookies, and crackers intended for gluten-sensitive or diabetic consumers. The majority of bakery goods, including cookies, are made with refined wheat flour; switching to finger millet will improve the nutritional value of these goods. Therefore, an effort was made to create nutritious finger millet-based cookies, and both their sensory and nutritional evaluations were performed. (Rai et al. 2014)

The Objective**s** of this study is:-

1. Preparation of Finger Millet (FM) cookies incorporated with Elephant Foot Yam (EFY) powder
2. Formulation of cookies by changing the ratio of FM:EFY
3. To study the Physico chemical analysis of developed EFY incorporated FM cookies

CHAPTER 2
REVIEW OF LITERATURE

2.1 Finger Millet

Eleusine coracana, often known as finger millet, is a cereal that is grown mostly in India's states of Uttar Pradesh, Bihar, Tamil Nadu, Karnataka, and Andhra Pradesh as well as Nepal. The crop is mostly grown in Africa's easternmost countries, primarily in Uganda, Kenya, and Tanzania, as well as to a lesser extent in Ethiopia, Rwanda, Malawi, Sudan, Zambia, and Zimbabwe.Africa is where finger millet was domesticated. It has been speculated that domestication may have taken place somewhere between western Uganda and the Ethiopian highlands of Eastern Africa, while the precise location is uncertain (de Wet 1995). Around 3,000 years ago, the crop was brought from Africa to India, where the continent later developed as its secondary centre of diversification. (Dida, et al. 2006)

The subfamily *Chloridoideae* of the *Poaceae* family includes species like finger millet (*E. coracana*) and those that are related to it. The crop is a member of the *Eleusine* genus, which has eight species that are both annuals and perennials. Finger millet is a tufted annual that matures in three to six months and grows to a height of between 40 and 150 cm. The stems are compact, glabrous, and upright. The leaf blades are folded, striated, linear, tapering to an acute point, and frequently have ciliated borders. Three to twenty spikes, grouped in the shape of a bird's foot, make up the inflorescence. The term "finger millet" refers to it because it looks like a hand's fingers in which every spike has roughly 70 spikelets that are alternately placed on the rachis and each spikelet contains four to seven seeds. The seeds range from 1 to 2 mm in diameter. The smooth, globose caryopsis (seed) can be brown, reddish brown, black, orange red, purple, or white. (Duke, et al., 1983)

One of the lesser known cereals, finger millet (Eleusine coracana), has a number of health advantages, some of which are linked to its polyphenol and dietary fibre content. For those in low-income classes in India, it is a crucial staple food. Due to its high concentration of dietary fibre (18%), phenolic compounds (0.3-3%), and calcium (0.38%), its usefulness in terms of nutrition is well understood. Additionally, they are known for their positive benefits on health, including their anti-diabetic, anti-tumor, anti-atherosclerogenic, antioxidant, and antibacterial qualities. (Devi, et al., 2011)

We looked at the physicochemical (pH, total titrable acidity (TTA), proximate, mineral analyses), and antioxidant properties of germinated and raw finger millet (Eleusine coracana). The findings demonstrated that during millet germination, there was a decrease in pH (8.50-7.60) and a concomitant rise in TTA (0.0038-0.18 g/L). After germination, the millet's approximate composition for finger millet showed a little rise in protein (7.61%-7.81%) and crude fibre (5.54%-8.81%) with decreases in fat (3.84%-2.73%). Several elements, including magnesium (1,028.42-1,763.50ppm), calcium (36.42ppm), sodium (150.00ppm), potassium (470.00ppm), zinc (20.00ppm), and iron (66.00ppm), were discovered to be abundant in millet. These minerals either reduced or rose with germination. Since the DPPH for finger millet ranged from 70.00% to 72.14%, study of the other parameters was also omitted in the same way. (Owheruo, et al., 2019)

The goal of the study was to develop cookies that were fortified with calcium and iron. The goal of this study was to create the ragi-infused cookies that were nutritionally enhanced. The finger millet's chemical makeup found that it contains 73.3 mg of total carbohydrates per 100 gram of product. There are over 6.2 mg of protein in 100 g of finger millet. Compared to other regularly consumed cereal grains, finger millet has a greater total ash content. The ash level of finger millet has been determined to be close to 1.5 mg/100 gm. The amount of calcium in ragi was determined to be 320 mg/100g. The greatest source of both calcium and iron is finger millet. The iron content of the ragi was 3.8+0.1 mg/100 gram. By include finger millet in our daily diet, we may prevent calcium insufficiency, which results in problems with our bones and teeth, as well as iron deficiency, which results in anemia. A sensory evaluation research served as the foundation for standardizing the recipe for cookies with added iron. It was found that cookies made with 30% ragi were very well received. It was discovered that the product's iron and calcium content was 9.5 + 0.1 & 152 + 0.1 mg/100 gm. A helpful tactic to maximize the consumption of food rich in functional components is to use 30% ragi when making cookies. (Bhoite, et al., 2018)

The extruded morning cereal made from finger millet, soybean cake, and carrot pomace was fed to rats in the study, and its effects were assessed in terms of macro- and micronutrients, amino acids, in-vivo protein quality, growth performance, and biochemical indices. FSC: Finger millet, soybean cake, and carrot pomace were blended and extruded into ready-to-eat breakfast cereal, whereas FS: Finger millet: Soybean Cake (75:25), FC: Finger millet: Carrot Pomace (90:10), and FC: Finger millet: Soybean Cake: Carrot Pomace (60:25:15)% were single ingredients. The amount of crude protein was significantly higher in FSC (19.2 g/100 g) than it was in F (10.2 g/100 g). The mineral with the highest concentration was potassium (34.7-41.4 mg/100 g). The highest concentration of total and branch chain amino acids (72.8–75.8 and 13.2-14.8 g/100 g of protein) was found in FSC. The biological value and in-vivo protein efficiency ratio of rats fed follow the same pattern, with FSC (2.16 and 93.0%) having the greatest values. Experimental samples have no harmful effects on rats, according to biochemical indicators. The nutritious (macro and micronutrient) values of finger millet, soybean cake, and carrot pomace were improved using extrusion. Sample FSC, however, performs better than other experimental meals and is comparable to casein in terms of high protein, total amino acids, biological value, growth performance, and biochemical indicators. It also received the highest rating for general appeal. (Temitope, et al., 2022)

In Western Uganda, where finger millet porridge is frequently consumed as a supplemental food, child malnutrition is a significant issue. This study used Moringa oleifera, Cucurbita maxima, and lactic acid fermentation to enhance the nutritional value and safety of finger millet porridges. The antibacterial and organoleptic qualities of the enhanced millet porridges were evaluated using the agar diffusion pouring technique and a seven point hedonic scale, respectively. Proximate analysis, iron, zinc, and vitamin A levels of composite flours were determined using AOAC methods. The porridges were created with the intention of providing children aged 7 to 24 months with at least 60% of their daily requirements for protein, vitamin A, iron, and zinc. Utilizing lactic acid starter cultures, they were fermented. Chi-square tests were employed to compare the percentage of moms who approved of the porridges. Analysis of variance was performed, and Duncan's test with a 0.05 significance level was used to assess mean differences. The greatest nutritional composition and antibacterial qualities were found in fermented millet porridge using 7% M. oleifera leaves compared to 17% C. Mothers were more receptive to maxima meat. Thus, in Western Uganda and most underdeveloped nations, the porridges have the potential to address inadequate nutrient intakes and diarrheal illnesses linked to child malnutrition. (Isingoma, et al., 2015)

Due to urbanization, which has increased wheat importation, cookie consumption is rising in Nigeria. Cookies are a ready-to-eat easy snack for all ages. This study investigated the use of locally grown crops for the making of cookies in an effort to lessen the negative economic effects of wheat importation. Combinations of wheat flour, germinated finger millet, and African yam bean were used to make cookie samples. Utilising design professionals, several flour blend amounts were obtained. The functional, antinutrient, and proximate features of the flour mixtures were assessed, and the sensory qualities of the cookies were determined. The moisture, protein, fat, crude fibre, ash, and carbohydrate contents of the composite flour ranged from 12.20 to 12.54, 8.89 to 10.62, 1.31 to 1.65, 1.13 to 1.39, 1.82-1.48, and 74.33 to 72.66%, respectively. Calcium, phosphorus, potassium, and sodium, in that order, were present in the flour in amounts ranging from 9.064 to 9.10, 0.29 to 0.32, 0.42-0.45, and 0.24 to 0.28%, respectively. The flour's anti-nutritional qualities for tannin, phytate, oxalate, and trysin inhibitor, respectively, ranged from 0.0074 to 0.0098%, 0.1700 to 0.1990%, 0.0905 to 0.1080%, and 1.2500 to 1.4900%. In terms of bulk density, water absorption capacity, oil water capacity, foaming capacity, and foaming solubility, the functional parameters of the composite flour ranged from 0.66 to 0.67 g/ml, 25.87 to 27.48 g/ml, 6.11 to 8.12 g/ml, 0.75 to 0.83 g/ml, 106.65 to 124, and 91.70 to 99.75 g/100g, respectively. Colour, taste, texture, and sharpness were the four senses that were examined. According to this study, the nutritional and functional qualities of the flour significantly improved while the ant nutrients decreased. (V.F, et al., 2018)

They analyzed the effect of replacement of wheat flour with 0, 20, 40, 60, 80 and 100% finger millet flour (FMF), 60% FMF, emulsifiers and hydrocolloids on the batter microscopy, rheology and quality characteristics of muffins. As the level of FMF increased, the amylograph's peak viscosity, breakdown, and setback values dropped. Microscopy of the muffin batter revealed that adding more FMF than 60% to the blend reduced the number of air cells, indicating inadequate air incorporation. Density, viscosity, volume, and overall score of the muffin batter dropped as the FMF content grew from 0 to 100%, however crumb firmness increased. Above 60% FMF, a negative impact on the cake's quality qualities was seen. Consuming polysorbate-60 and hydroxypropylmethylcellulose together greatly improved the viscosity, overall quality of the muffin in terms of volume, grain, and texture, as well as the batter properties of muffins made with 60% FMF. (Rajiv, et al., 2011)

In the current work, biosilica particles recovered from finger millet husk (FMH) and coconut rachilla fibre are combined to create high-toughness epoxy biocomposites for lightweight and cost-effective technological applications. This study aims to evaluate the effects of FMH biosilica particles added at different concentrations on the mechanical and wear parameters, as well as the thermal and hydrophobic behaviour, of epoxy composites manufactured from coconut rachilla fibre. With respect to tensile strength, impact strength, flexural strength, and hardness, the combination of 3 vol.% FMH biosilica particle and surface-treated palmyra sprout fibre as a reinforcing material has the greatest values at 155 MPa, 6.17 J, 183 MPa, and 92 D-shore, respectively. With the inclusion of 5 vol% FMH biosilica particles, the coconut rachilla fibre and FMH biosilica-generated epoxy composite exhibit the lowest specific wear rate and coefficient of friction (COF) of 0.006 mm3/Nm and 0.42, respectively. The maximal initial breakdown temperature for these composites is 342 °C, and the glass transition temperature is 102 °C. They also have outstanding thermal characteristics. These composites also maintain their hydrophobic characteristics indefinitely, and the ERB3 composite has the lowest contact angle at 81°. These epoxy composites, which have enhanced mechanical, thermal, and wear qualities, could be used in a variety of technical applications that require high load bearing capacity and biodegradability, including sporting goods, cars, furniture, transport, and aviation. (Sivamurugan, et al., 2011)

2.2 Elephant Foot Yam

The stem tuber crop known as elephant foot yam (*Amorphophallus paeoniifolius*) is rewarding and successful. Due to the crop's tolerance for shade, simplicity of cultivation, excellent production, low incidence of pests and diseases, consistent demand, and reasonably low price, it is becoming more and more popular. After thorough cooking, tubers are primarily eaten as vegetables. Tubers rich in starch are used to make chips. The leaves and delicate stems are frequently used as vegetables. 18.0% carbohydrate, 1%–5% protein, and up to 2% fat are all present in tubers. Leaves include 3% carbohydrates, 2-3% protein, and 4-7% crude fiber. Because oxalates are present in large amounts, tubers and leaves are extremely acidic. Typically, aridity is eliminated by boiling for an extended period of time. Elephant foot yam cultivation is only practiced in South East Asia, India, the Philippines, and Sri Lanka.In February, pits of 60 x 60 x 45 cm are constructed at a spacing of 90 x 90 cm after one or two ploughs. 60 x 60 cm is the new minimum space between trenches for small- to medium-sized tuber harvesting. Topsoil, well-dried farmyard manure, and wood ash are half-filled into the pits.

Corms are used in *Amorphophallus* propagation. Corms that were gathered in November are kept in airtight spaces. The corm is divided into 750–1000 g sets, each bearing a piece of the centre bud, before planting throughout the month of February. Cut corms are covered in wood ash or cow dung slurry and let to dry in some shade. For planting at a closer spacing of 45 x 30 cm, the rapid seed corm production technique recommends using cormels and small sett transplants of 100 g size. In the pit, planting material is arranged vertically. Pits are mulched with organic materials like green leaves or paddy straw once the planted tubers have been compacted.

Rainfed agriculture is primarily used to raise *Amorphophallus*. Early stages of the crop receive a light irrigation during times when the monsoon arrives later than usual. Stasis in the water can harm crops. The most crucial procedure with *Amorphophallus* is the application of mulch immediately following planting. It prevents weed growth in addition to preserving soil moisture and controlling soil temperature. Typically, a plant only produces one stem. If there are more than one, it is best to eliminate all but not the healthy one.When the top has completely wilted and dropped, underground corms can be dug up or harvested with a pick axe. After planting, the crop will be available for harvest 8 to 9 months later. Tubers, however, can be harvested after six months if the market price is higher with a 30-40 t/ha yield is standard. (ICAR, 2021)

Traditional commercial growing locations for elephant foot yam include the states of Andhra Pradesh, Tamil Nadu, Kerala, and West Bengal. According to the study, elephant foot yam farming in Kerala, Andhra Pradesh, and Tamil Nadu has a gross cost of Rs 1,73,105, Rs 93,450, and Rs 1,68,032 per ha, respectively, and benefit-cost ratios of 1.38, 1.38, and 1.50. The study found that all NPK fertilizers were being used excessively in Kerala, highlighting the need to rationalize their usage. However, Tamil Nadu and Andhra Pradesh had room to increase their use of all NPK fertilizers, with the exception of nitrogenous fertilizers.Spending on manures in Tamil Nadu and hired labor in Kerala can both be increased without having a negative impact on the crop's output. The investigation has shown that reorganizing farm resources is necessary to increase returns on elephant foot yam farms in India using various production techniques. (Srinivas, et al., 2005)

In Rante Dengen, Lembang Karre Limbong, Nanggala District, North Toraja Regency, research on the relationship between the growth of leaves, stems, and roots of elephantiasis plants in each application of bokashi fertilizer and NPK fertilizer was conducted from July to October 2022. The goal of this study was to ascertain how the bokashi from chicken waste and NPK fertilizer applications affected the growth of elephantiasis leaves, stems, and roots. An experiment using two treatment factors—liquid organic fertilizer made from chicken manure and NPK—was conducted using a randomized group design (RB). The findings demonstrated that the optimal treatments were applying bokashi at a dose of 400 g/plant and NPK fertilizer at a dose of 20 g/plant. The relationship between the variables affecting the growth of the leaf, stem, and roots is linear. Stem diameter and akare's volume are the factors that have the biggest effects on a plant's increase in dry weight. We sincerely appreciate the financial support provided for this work by DRPM, the Directorate General of Higher Education, Ministry of Education and Culture (Kemendikbud Ristek DIKTI), Indonesia, and the Indonesian Christian University of Toraja. (Limbongan, et al.)

Cake is a wheat-based bakery product in which fat and sugar limit the growth of the gluten network. The inclusion of gluten-free flour is an effective way to weaken the gluten in wheat flour. Elephant foot yam is a tuber that has a number of health advantages. In order to create composite flour for cake development, wheat flour (WF) and elephant foot yam flour (EFYF) were combined. The impact of the EFYF addition on the cake and dough formulation's quality was identified. Depending on the ratios of the two types of flour, the powders made from the blend of EFYF and WF had different capacities for absorbing water and fat. Different concentrations of EFYF were added to WF (10, 20, 30, and 40%), and the dough quality was assessed. The EFYF's insertion damaged the gluten network because it doesn't include gluten. In comparison to the control cake, cakes made with EFYF enhanced flours up to a 20% addition showed a similar texture and sensory properties ($p>0.05$). The cake with 20% EFYF performed the best across the board and is hence suggested for cake creation. (Kaushik, et, al., 2020)

Lacto-fermentation is used to create the most popular fermented foods. Amorphophallus paeoniifolius, also known as Elephant Foot Yam, is a plant used in this study to produce "Lacto-pickle" while Lactobacillus plantarum is present. Utilising a complete factorial Central Composite Design, Response Surface Methodology was used to assess the impacts of three ideal factors on the formation of lactic acid: salt concentration (8%, w/v), inoculum volume (10%, v/v), and incubation period (22 days). The most agreeable treatment from an organoleptic standpoint was determined to be the LA fermentation with an 8–10% brine solution. On a fresh weight basis, the EFY Lacto-pickle with 8 and 10% (w/v) brine solutions included around 55–68 g/kg of starch, 1.3–1.6 g/kg of total sugar, 37.9–38.5 g/kg of crude protein, and 22.5-23.0 g/kg of fat. The viability of the strains was assessed throughout the prolonged (6 weeks) room-temperature storage of EFY Lacto-pickle, and viable cell counts were steady. Additionally identified and demonstrated to have inhibitory activities towards pathogens is the antagonistic activity of viable cells against food-borne pathogenic microorganisms. (Behera, et al., 2018)

The goal of the study was to create an edible film based on elephant foot yam starch (EFYS) by combining Xanthan (XG) and agar-agar (AA). The greatest values for film thickness and density, respectively 0.199 mm and 2.02 g/cm3, were discovered for the film containing 2% AA. Film thickness and density increased as hydrocolloid concentration increased. The lowest values of water vapour transmission rate (1494.54 g/m2) and oxygen transmission rate (0.020 cm3/m2) were found for the films with 1% XG and 1.5% AA, respectively. The barrier properties of the film varied with the hydrocolloids. The use of hydrocolloid also improved mechanical and thermal qualities. The film containing 2% AA was found to have the highest tensile strength (20.14 MPa) and glass transition temperature (150.6 °C). Through the peak in X-ray diffraction analysis, which grew with an increase in the hydrocolloids' concentration, the change in crystallinity was noticed. (Nagar, et al., 2020)

Elephant foot yam (EFY) starch has undergone limited dual modification experiments, but none have looked at the combined effects of citric acid (CA) and ultrasonication (US). In the current investigation, various CA concentrations with and without US were applied to EFY starch. Changes in several characteristics, including functional, morphological, thermo-pasting, etc., were investigated. The capacity of starch to absorb water and oil was improved by both treatments. With the exception of pasting viscosity and pasting temperature, US adjustment significantly (p 0.05) reduced pasting properties. The glass transition temperature decreased as a result of CA alteration, which was further lowered by US. When starch was modified with CA, individual granules appeared to aggregate, but CA + US fractured the aggregates and produced surface fissures and cracks. The concentration of citric acid was increased, which improved crystallinity overall. The

FTIR study of functional groups revealed new peak development (1710-1690 cm1) connected to CA alteration. The findings indicated that CA and CA + US altered the functionality, morphology, and other structural attributes of EFY starch, allowing us to employ the modified starch in a variety of applications, including thickening agents, extruded goods, and baking products. (Singh, et al., 2020)

The goal of the current study was to evaluate the physico-chemical characteristics of two types of elephant foot yam (Amorphophallus paeoniifolius) flour. It was discovered that the corms of variety NDA-9 were of higher physical quality. The unblanched NDA-9 flour was of excellent quality. NDA-5 and NDA-9 had peel percentages of 17.80 and 11.60%, respectively. NDA-5 and NDA-9 had moisture contents of 77.50 and 76.93%, respectively. The average flour recovery (%) for both blanched and unblanched grains was the same, at 22.79 %. Blanched and unblanched vegetables had a mean water absorption capacity (%) of 51 and 57 percent, respectively. The average values for NDA-5 were 11.20, 88.90, 7.43, 0.50, 2.69, 4.97, 73.42 percent, crude protein, crude fat, crude fibre, total ash, carbohydrate, and energy, respectively. The average values for NDA-9 were 11.00, 89, 6.49, 0.65, 3.20, 4.87, 73.79 percent, crude protein, crude fat, crude fibre, total ash, carbohydrate, and energy, respectively. (Yadav, et al., 2016)

In order to reduce the negative effects of cholesterol and unsaturated fatty acids, which are prevalent in meat, plant-based substitutes are now being used in the development of processed foods that contain meat. There are a number of underutilised plants that could replace meat in processed meat-based goods. In this study, the chicken burger patties were replaced with lasia stalk and elephant foot yam flour. Elephant foot yam, lasia stalk, and chicken meat were used in the formulation of the treatments as T1 (30%, 30%, 40%), T2 (25%, 25%, 50%), T3 (25%, 15%, 60%), T4 (15%, 25%, 60%), and T5 (100% chicken), respectively. The ability to cook, as well as proximate and sensory analysis, were examined for developed patties. According to the study's findings, there were significant differences (p0.05) between the treatments in the cooking characteristics shrinkage, water holding capacity, cooking yield, and cooking loss. In comparison to other compositions, the T1 and T3 had a better water holding capacity, a higher cooking yield, a lower shrinkage, and a lower cooking loss. The treatments differed significantly (p0.05) in terms of moisture content, protein, fat, fibre, and ash content. The replacer-incorporated patties contained more fibre and less fat than the control. For the T4 composition, colour, flavour, and taste received the highest sensory evaluations. T5, however, received superior marks for its texture, odour, and general acceptance. In conclusion, patties made with 15% lasia stalk flour and 25% elephant foot yam flour produced favourable physiochemical and sensory results. (Himanshani, et al., 2022)

CHAPTER 3

MATERIALS

3.1. Collection of finger millet

The finger millet was collected from the local grocery shop near Integral University, Lucknow.

3.2. Collection of elephant foot yam

Elephant foot yam was obtained from the hypermarket located in Lucknow, Uttar Pradesh.

3.3. Raw Material

Table 3.1: Lists of Ingredients used

S.No.	Ingredient	Company
1.	Finger millet flour	Organic Tattva
2.	Elephant foot yam	…………….
3.	Sugar	GMC
4.	Butter	Amul
5.	Oil	Pansari
6.	Milk	Amul
7.	Baking Powder	Weikfield
8.	Baking Soda	Weikfield
9.	Salt	Tata

Table 3.2: Lists of Instruments used

S.No.	Instrument	Model No.	Company
1.	Weighing Balance	ALE-223	K-Roy
2.	Baking Oven		
3.	Electronic Balance	MSW10A/VA	WENSAR
4.	Sieve		

5.	Tray dryer		
6.	Hot air oven	Asianoven14	ASIAN
7.	Grinder	GX 15	Bajaj
8.	Desiccators		
9.	Burette stand		
10.	Incubator	CI-10 Plus	Remi

Table 3.3: Lists of Glasswares/Tools used

S.No.	Glassware	Specification	Quantity	Company
1.	Petri plates	7.5cm diameter	10	Borosil
2.	Conical Flask	500ml	2	Borosil
3.	Beaker	50ml 250ml	5 3	Borosil
4.	Measuring cylinder	10 ml 100ml	1 1	Borosil
5.	Dropper	3ml	1	SPYLX
6.	Knife	Stainless steel	1	Agaro
7.	Kneading Board	Wooden	1	Flora ware
8.	Shape cutter	Stainless steel	1	Agaro
9.	Stainless- steel utensils	Cook and serve big bowl Table spoons Laddel	1 3 1	Hawkins
10.	Test Tube	Glassware	40	Borosil

Table 3.4: Lists of Chemicals used

S.No.	Chemicals	Chemical formula	Company
1.	Potassium meta bi sulfite		
2.	Phenolphthalein indicator	$C_{20}H_{14}O_4$	Qualigens, Nice and Merck
3.	Sodium hydroxide	NaOH	Fisher Scientific (Qualigens)
4.	Buffer solution		
5.	2,2-diphenyl-1-picrylhydrazyl (DPPH)	$C_{18}H_{12}N_5O_6$	Sisco Research laboratory
6.	Di ethyl ether		
7.	Sulfuric acid		
8.	Folin's reagent	$C_{10}H_5NaO_5S$	HiMedia Laboratories

METHODOLOGY

3.4. Processing of Raw Material

3.4.1. Processing of Finger millet

Finger millet was selected on the basis of color, texture, appearance and was washed and cleaned for removing the dust particles.

It was then sun dried for about 24 hours within two days which was stored for further processing.

3.4.2. Processing of Elephant Foot Yam

Elephant foot yam was procured according to the required weight, shape, and size. Then it was washed, peeled, and cut into desired shape. The slice was soaked in water after which it gone through blanching by adding 0.1% KMS at 70 °C for 5 minutes. The blanched pieces was cooled down and dried in tray dryer at 60 °C for 36-48 hrs.

3.5. Preparation of Flour –

3.5.1. Finger Millet Flour – The dried raw material was simply grinded in a mixer grinder and was sieved with decreasing mesh size in order to achieve finely grinded flour.

The obtained flour were then stored in an air tight container for further analysis.

3.5.2. Elephant Foot Yam Flour - After drying, EFY was cooled down and kept in a container until it is grinded. Later on, it was processed for grinding in a mixer grinder at high speed.

The first sieving of grinded sample was done with mesh of 300 micron after which the obtained flour was again grinded in a mixer grinder and finally sieved with mesh of 150 micron. With this step, the elephant foot yam flour was obtained finally.

The reason for double sieving of EFY is that no solid granules will be present at the time of incorporating EFY flour.

3.6. Preparation of Cookies

3.6.1. Finger Millet Cookies -

3.6.1.1. Mixing of Sugar and Butter – The refined sugar was used as a sweetening agent because it is easy to store due to its less moisture content (≤1.5 %) and low Relative Humidity (20-25 %). The butter was also added due to its low moisture content as it helps in providing structure, tenderness in cookies. The mixture was prepared by adding 10 gm of butter and 15 gm of sugar to incorporate air so that it allows mixture to increase in volume. The mixing was done continuously for 15 minutes with 5 ml of vegetable oil which acts as a binding agent and provides shiny texture to the baked cookies.

3.6.1.2. Addition of Baking Soda, Baking Powder and Salt – Baking soda and Baking powder acts as a leavening agent which helps in releasing gases that forms bubbles and aerate the batter or dough during the baking process and salt are added to enhance the flavour of the cookies.

Baking soda, Baking powder, and Salt are added in the amount of 0.25 gm, 0.5 gm, and 0.25 gm respectively along with 5 ml of vegetable oil with continuous mixing.

3.6.1.3. Adding Finger Millet Flour – For formation of dough**,** finally the finger millet flour was added to the mixture and kneaded properly until it becomes soft**.** The dough was kept in refrigerator for 10 minutes approx to stable the fat present in dough.

3.6.1.4. Baking of Cookies – The prepared dough was further cut into standard shape and size of cookies and was baked in baking oven for 20-25 minutes at 220 °C. The cookies prepared were stored in an air tight container at room temperature for further analysis.

Product Preparation

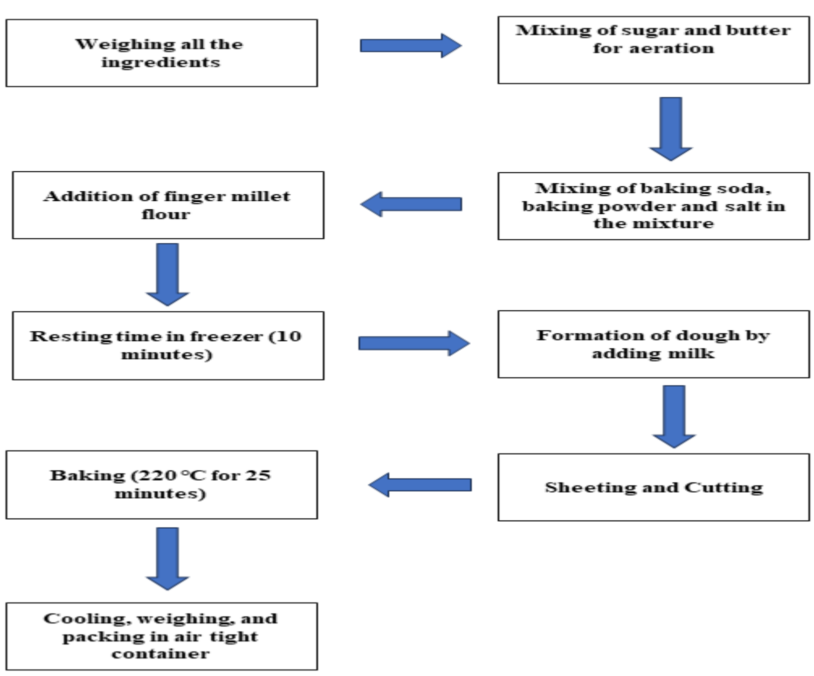

Figure:- 3.1 Standard Preparation of Ragi Cookies

3.6.2. Incorporation of EFY powder in ragi cookies –

Powdered EFY was added during the ragi flour incorporation. Once the EFY flour is completely homogenized with the ragi flour and the dough was formed, it was processed for cooking.

3.7. Optimization of process parameters –

3.7.1. Ragi flour content – Different concentrations (50, 45, 40, 35, 30gms) of ragi flour were taken for the optimization of cookies. The selected amount were mixed with the mixture prepared for dough formation.

3.7.2. EFY flour content – Different amount (0, 2, 10, 15, 20gms) of EFY flour was added with the different concentrations of ragi flour to get the best combined concentration during the optimization of cookies.

3.7.3. Effect of Butter – Butter was added as it gets easily melt at low temperature (because it contains water) than other fats which allows cookies to spread evenly while baking and gives good rise on top.

3.7.4. Effect of Sugar – Addition of sugar makes cookies more browner and crisper and acts as a shelf life improver.

3.7.5. Effect of Oil – Computing of oil helps in giving tenderness to the cookies as it does not solidify when cooled down and due to its 100% richness in fat it doesn't make cookies more fluffy which is good to store for longer time.

Table3.5. Optimized parameters

Raw Material	Different concentration (50gm)			
Finger Millet Flour	45 gm	40 gm	35gm	30 gm
EFY Powder	5 gm	10 gm	15 gm	20 gm

Sugar	Salt	Oil	Baking soda	Baking powder	Butter	Milk
15 gm	0.25 gm	15 ml	0.25 gm	0.5 gm	10 gm	10 ml

3.8. Cooking of EFY incorporated RAGI cookies at optimized condition

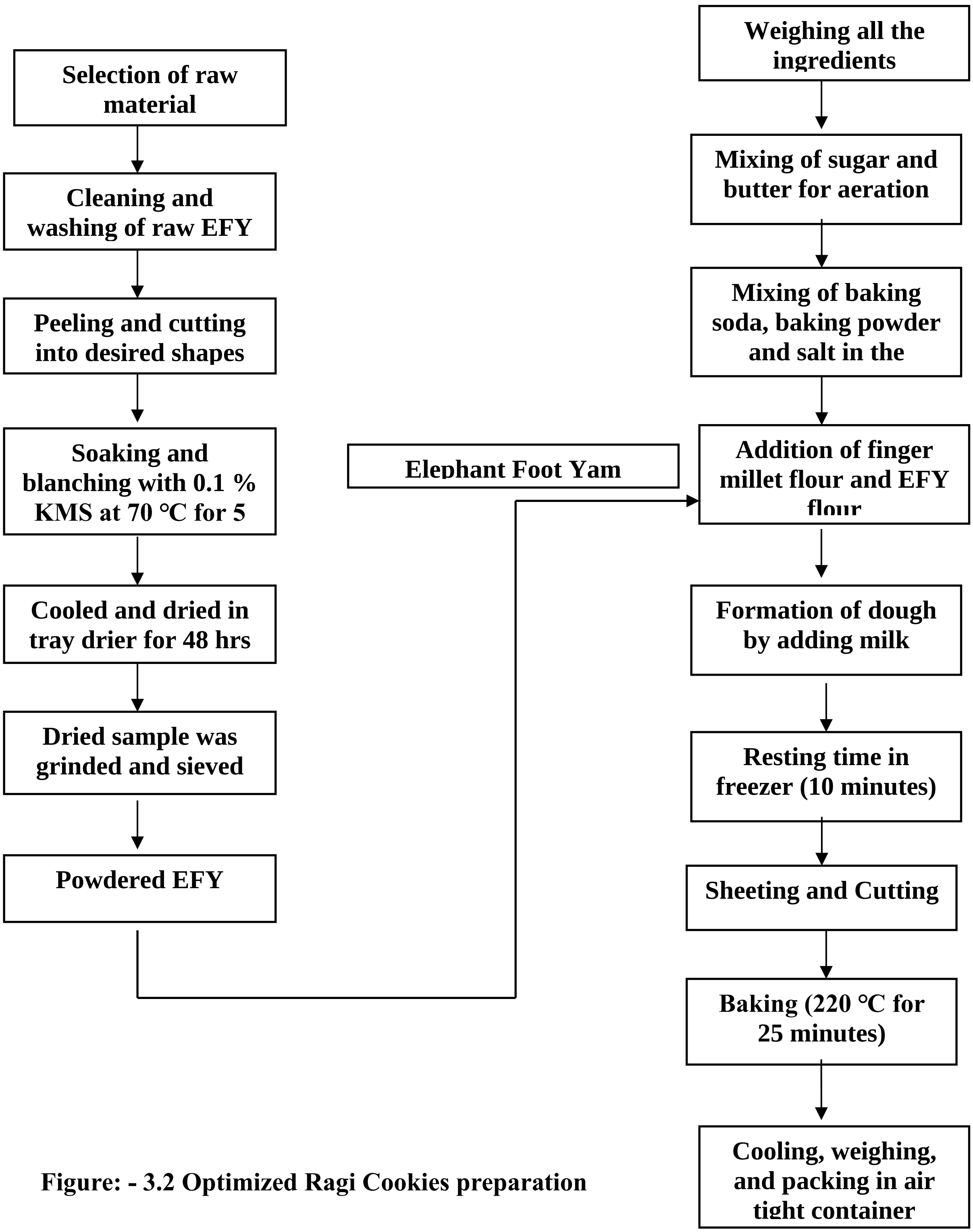

Figure: - 3.2 Optimized Ragi Cookies preparation

3.9. Quality Analysis – The product was prepared in the month of April 2023. The quality analysis of functional ragi cookies was started in May – July 2023 and continued for 60 days at 20 days interval.

3.9.1. Physico-chemical Analysis

3.9.1.1. Moisture Content - Moisture content was estimated with finely ground sample (2g) and was weighed accurately in a covered dish previously dried at 98-100°C, cooled in desiccator and weighed soon after reaching room temperature.

The cover of petri dish were loosen and placed in hot air oven that was thermo statistically controlled at 110 ℃ for 2 hours. Immediately the cover were tightened on dish, transferred to desiccator and weighed soon, after reaching room temperature.

The resultant loss in weight was calculated as percentage moisture content on dry basis.

$$\mathbf{Moisture\ Content}(\%) = \frac{[(\mathbf{W1-W2})]}{\mathbf{W}} \times \mathbf{100} \qquad \text{(Equation 3.1)}$$

W = Weight of sample

W1 = weight of sample + weight of petri dish.

W2 = Weight of dried sample + weight of petri dish.

3.9.1.2. Ash Content - Ash was estimated by weighing 5 gm sample and transferred in pre-weighed porcelain crucible. The weighed sample was charred till smoke ceases. The crucible was then transferred to muffle furnace maintained at 550 ℃ and ignited until light grey ash was obtained (nearly for 5 or 6 hours). The crucible was then cooled in dessicator and weighed. The results were reported on dry weight basis.

$$\mathbf{Ash\ Contetnt}(\%) = \frac{[(\mathbf{W1-W2})]}{\mathbf{W}} \times \mathbf{100} \qquad \text{(Equation 3.2)}$$

W = Weight of sample

W1 = weight of sample + weight of crucible.

W2 = Weight of ash + weight of petri dish (after ashing)

3.9.1.3. Fat Content - Fat content was estimated by weighing accurately 3 g of grounded sample and transferred to the thimble and defatted with diethyl ether poured in pre-weighed container and all are placed in Fat Analyzer apparatus performed through boiling followed by rinsing for 2-4 hours at 40°C.

The residue was procured and ether is removed from container by evaporation through heating mantle.

The fat was calculated by weighing the container after heating deduced by the initial weight of container.

$$\mathbf{Fat}(\%) = \frac{[\mathbf{Loss\ in\ weight\ of\ sample} \times \mathbf{100}]}{\mathbf{Weight\ of\ sample}} \qquad \text{(Equation 3.3)}$$

3.9.1.4. Protein Content - The protein content was estimated according to the Spectrophotometer method.

Two standard samples (a and b) was prepared with distilled water in which sample (a) contains 50 ml of 2% sodium carbonate and 50 ml of 0.1 N NaOH whereas sample (b) contains 10 ml of 1.56% of copper sulfate and 10 ml of 2.37% of sodium potassium tartarate solution.

Secondly, alkaline copper solution was prepared by mixing 98 ml of sample (a) and 2 ml of sample (b) after which BSA solution was made with 1 mg/ml concentration using distilled water and Follin reagent was produced with 1 ml/ml concentration along with dissolving 2 gm of test sample in 10 ml distilled water.

The procedure follows with the 12 test tubes for one sample in which 10 test tubes are linearly arranged and other 2 test tubes are kept separately in which one is for test sample and other is identified as blank. The steps are as follows :-

1. Add 0.1 ml to 1 ml BSA solution in all the 10 test tubes from L to R using micro pipette of 1 ml.
2. Further, add 0 to 0.9 ml of NaOH in linearly arranged test tubes from R to L with same micro pipette.
3. Add 1 ml of prepared test sample in test sample test tube and 1 ml of distilled water in blank test tube.

4. Add 5 ml alkaline solution in all 12 test tubes and leave it for 10 minutes.
5. Later on, add 1 ml of follin reagent to each test tube and incubate the samples at room temperature for 30 minutes.
6. Finally, take OD at 660 nm through spectrophotometer and draw graph.

3.9.1.5. Crude Fiber - The crude fiber was estimated by taking 3 g of each fat free flour sample and digested first with 1.25% H2SO4, washed with distilled water and filtered, then again digested with 1.25% NaOH solution, washed with distilled water and filtered.

Then ignited the sample residue by placing the digested samples in a muffle furnace maintained for 3-5 h at temperature of 550-650 °C till grey or white ash was obtained.

The percentage of crude fiber was calculated after igniting the samples according to the expression given below.

$$\textbf{Crude fiber}(\%) = \frac{\textbf{Weight loss on ignition}}{\textbf{Weight of flour sample}} \times \mathbf{100} \qquad \text{(Equation 3.4)}$$

3.9.1.6. Carbohydrates - Carbohydrate content was calculated for cookies by difference method on dry using following formula:

Total carbohydrate = 100 – (fat + fiber + ash + protein) (Equation 3.5)

3.9.1.7. Energy - Energy content was calculated for cookies by factorial method AOAC (1995) on dry using following formula:

Energy (kcal) = 4.0 × protein (g) + 4.0 × carbohydrate (g) + 9.0 × fat (g) (Equation 3.6)

3.9.2. Physical Parameters of Cookies

3.9.2.1. Diameter - For the determination of the diameter, six cookies were placed edge to edge. The total diameter of the six cookies was measured in mm by using a ruler.

The cookies were rotated at an angle of 900 for duplicate reading. This was repeated once more and average diameter was reported in millimeters.

3.9.2.2. Thickness - To determine the thickness, six cookies were placed on top of one another. The total height was measured in millimeters with a ruler.

The measurement was repeated thrice to get an average value and results were reported in mm.

3.9.2.3. Spread Ratio - Spread ratio was calculated as diameter (length) to thickness ratio.

$$\textbf{Spread Ratio} = \frac{\textbf{Diameter}}{\textbf{Thickness}} \qquad \text{(Equation 3.7)}$$

3.9.3. Sensory Analysis - The sensory attributes were observed for 60 days at 20 day intervals. Hedonic Ratting Test was used to evaluate functional Ragi cookies sensory attributes such as colour, flavour, texture, taste, size etc.

The Hedonic Ratting test was used to evaluate sensory characteristics. This test is used to assess consumer acceptance of a product. The methodology is presented in detail below.

A panel of five expert judges of varying ages and eating habits was chosen, and the samples were served to them. The expert panelists were asked to rate the acceptability of the product based on their sense of organs on a scale of 9 points ranging from extremely like to extremely dislike. At the time of the evaluation, a test Performa was prepared and provided to them

Table 3.6:- Hedonic Scale table

Rating	**Score**
Like Extremely	9
Like very much	8
Like Moderately	7
Like Slightly	6
Neither like nor dislike	5
Dislike Slightly	4
Dislike Moderately	3
Dislike very much	2
Dislike extremely	1

CHAPTER 4
RESULTS AND DISCUSSION

This chapter presents the experimental results conducted to enhance the nutritive value of Ragi cookies with the incorporation of EFY flour under ambient condition.

During the analysis of cookies, optimized sample was selected on the basis of different concentrations and sensory acceptance of EFY enriched Ragi cookies after which 3 different samples were taken and their comparative study was done to get the best results.

Sample 1 – Market Cookies

Sample 2 – Standard Ragi Cookies

Sample 3 – Optimized Ragi Cookies

The experiment were carried out to determine various analysis of ragi cookies. The result of this investigation was discussed under the following heads :-

4.1. Physical characteristics of Finger Millet

The physical characteristics like shape, color, weight and the average diameter of the fully ripen finger millet obtained from the local grocery shop near Integral University, Lucknow are presented in Table 4.1.

Table 4.1: Physical characteristics of Finger Millet

S .No	Morphological characters	Parameters of Finger Millet
1.	Shape	Spherical
2.	Color	White to Brown in color
3.	Diameter	1-2 mm
4.	Length	……….
5.	Weight	2.5 gram / kernel
6.	Shelf life	12 months approx.

Effect on Physico-chemical characteristics of functional Finger Millet Cookies

4.2. Moisture Content

The storage period and Elephant foot Yam powder effected moisture content of packed ragi cookies is presented in figure 4.2. The moisture content decreased considerably due to the addition of EFY powder.

Table 4.2. Moisture Content (%) of Ragi Cookies

	Sample 1	Sample2	Sample3
Day 0	3.4	2.9	2.1
Day 10	3.1	2.7	1.9
Day 20	2.9	2.4	1.7
Day 30	2.5	2.1	1.4
Day 40	2.1	1.8	1.1
Day 50	1.9	1.5	0.9
Day 60	1.7	1.1	0.7

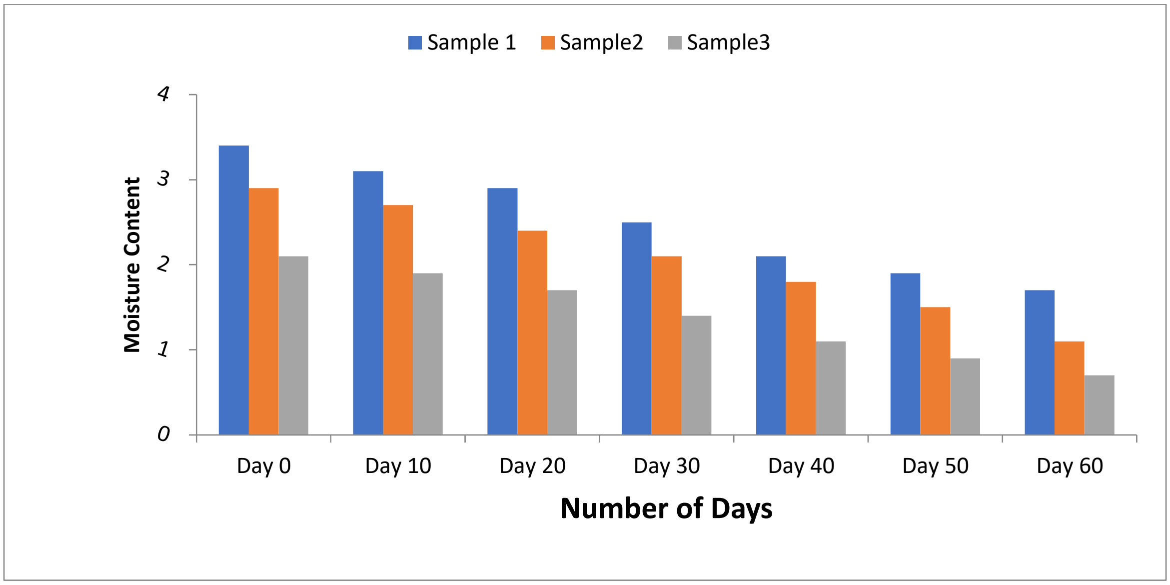

Figure- 4.1 Moisture Content (%) of ragi cookies

4.3 Ash Content

The effect of storage period and EFY powder on ash content of packed ragi cookies is presented in table 4.3

On critical evaluation of results, it was found that the ash content of Ragi cookies was considerably increased. The storage period considerably increased the ash content of ragi cookies, probably due to decrease in moisture content with increase in storage period. The packaging material had no significant effect on ash content.

Table4.3 Ash Content (%) of Ragi cookies

	Sample 1	Sample2	Sample3
Day 0	3.4	3.1	2.1
Day 10	3.1	2.7	1.9
Day 20	2.9	2.5	1.7
Day 30	2.5	2.1	1.4
Day 40	2.1	1.8	1.1
Day 50	1.9	1.5	0.9
Day 60	1.7	1.1	0.7

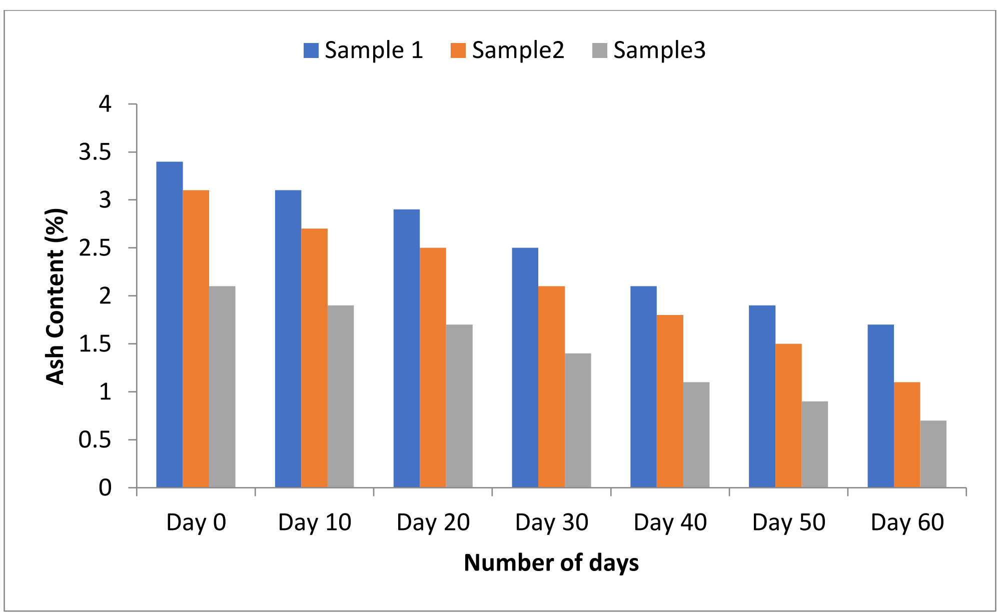

Figure – 4.2 Ash content (%) of ragi cookies

4.4 Fat Content

The effect of storage period and EFY powder on fat content of packed Ragi cookies is presented in table 4.4

Fat content was high in EFY powder incorporated Ragi cookies. The overall results clearly revealed that fat content of packed Ragi cookies increases considerably with the increase in storage period.

Table4.4 Fat content (%) of Ragi cookies

	Sample 1	**Sample2**	**Sample3**
Day 0	3.4	2.9	2.1
Day 10	3.1	2.7	1.9
Day 20	2.9	2.4	1.7
Day 30	2.5	2.1	1.4
Day 40	2.1	1.8	1.1
Day 50	1.9	1.5	0.9
Day 60	1.7	1.1	0.7

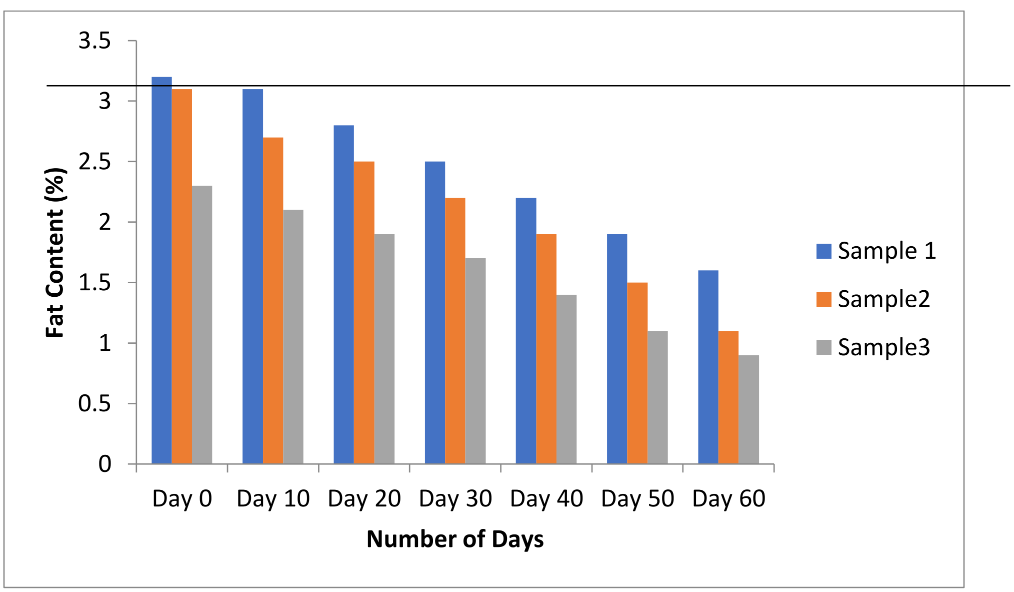

Figure- 4.3 Fat content (%) of ragi cookies

4.5 Protein content

The effect of storage period and EFY powder incorporated in packed ragi cookies on protein content is presented in Fig 4.5. Protein content is very high in EFY powder incorporated ragi cookies. The overall results revealed that the protein content increased considerably with the increase in EFY powder in ragi cookies.

Table4.5 Protein content (%) of ragi cookies

	Sample 1	Sample 2	Sample3
Day 0	3.4	2.1	5.5
Day 10	3.7	2.5	6.3
Day 20	4.1	2.7	6.9
Day 30	4.5	3.1	7.1
Day 40	5.1	3.5	7.5
Day 50	5.5	4.2	8.4
Day 60	6.2	5.5	9.1

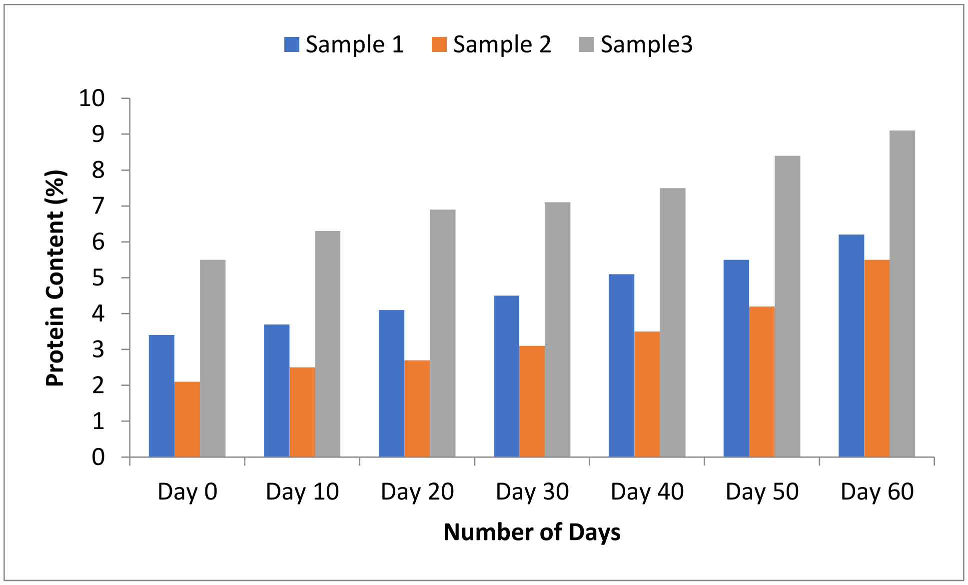

Figure - 4.4 Protein content (%) of ragi cookies

Sensory attributes of EFY powder incorporated ragi cookies influenced by packaging materials, storage period and EFY powder.

Sensory attributes of EFY powder incorporated ragi cookies were evaluated for fresh condition and at 30 days interval up to 3 months of storage. On 9 point Hedonic rating different attribute selected were color, taste, aroma, flavor, texture, appearance, and overall acceptability.

4.6 Color

The packaging materials, storage period and EFY powder showed an effect on EFY powder incorporated ragi cookies represented in Fig 4.6.The color is an important sensory attribute for any new developed product. The color of cookies varied due to addition of EFY powder. The color of cookies decreased slightly with storage period. Light sandy brown colour was observed due to EFY powder, which was actually a new development as people were attracted towards it.

Table 4.6 Color of ragi cookies

	Sample 1	**Sample 2**	**Sample 3**
Day 0	9	9.5	9
Day 15	8.5	9	8.5
Day 30	8	8.5	8
Day 45	7.5	8	7.5
Day 60	7	7.5	7

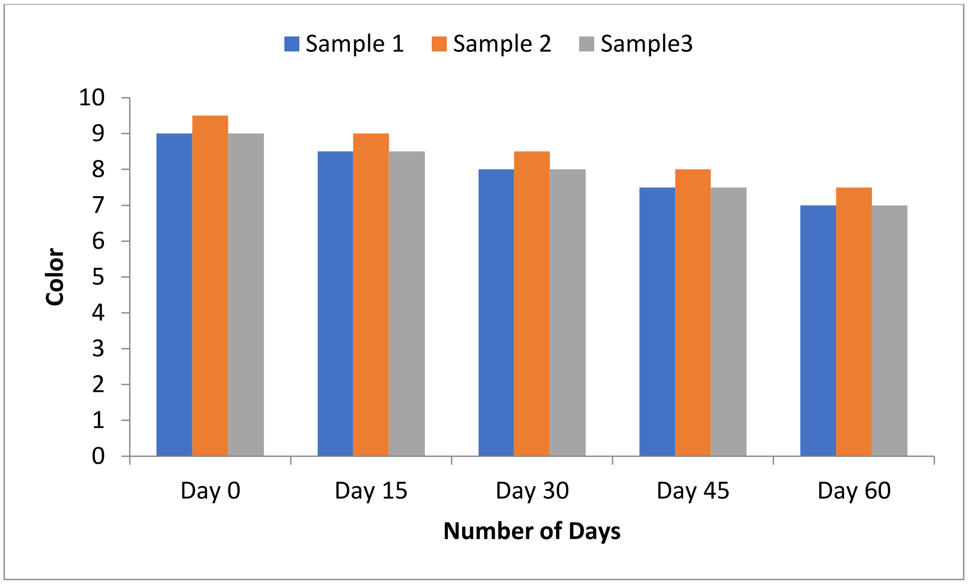

Figure-4.5 Color of ragi cookies

4.7 Taste

The packaging material, storage period and EFY powder affected on taste of EFY incorporated ragi cookies represented in Fig 4.7. The taste of cookies varied due to incorporation of EFY powder. After some time tastes change and it minor affected the sample, incorporated with EFY powder. The taste of the cookies was slightly reduced with increase in storage period.

Table 4.7 Taste of ragi cookies

	Sample 1	Sample 2	Sample3
Day 0	9	9.5	9
Day 15	8.5	9	8.5
Day 30	8	8.5	8
Day 45	7.5	8	7.5
Day 60	7	7.5	7

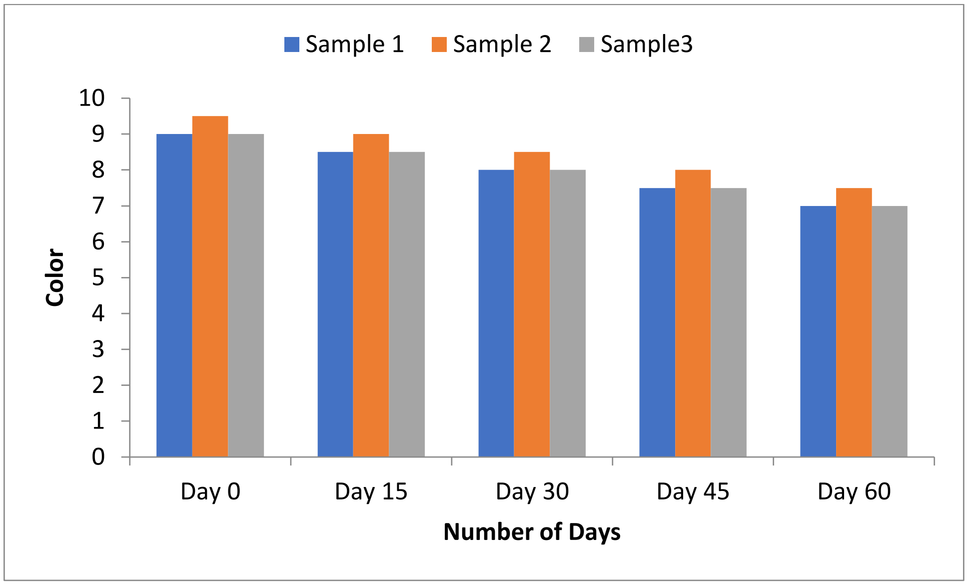

Figure- 4.6 Taste of ragi cookies

4.8 Aroma

The effect of packaging material, storage period and EFY powder on aroma of EFY incorporated ragi cookies represented in Fig 4.8. The aroma of cookies reduced with increase in storage period.

Table 4.8 Aroma of ragi cookies

	Sample 1	Sample 2	Sample3
Day 0	9	9.5	9
Day 15	8.5	9	8.5
Day 30	8	8.5	8
Day 45	7.5	8	7.5
Day 60	7	7.5	7

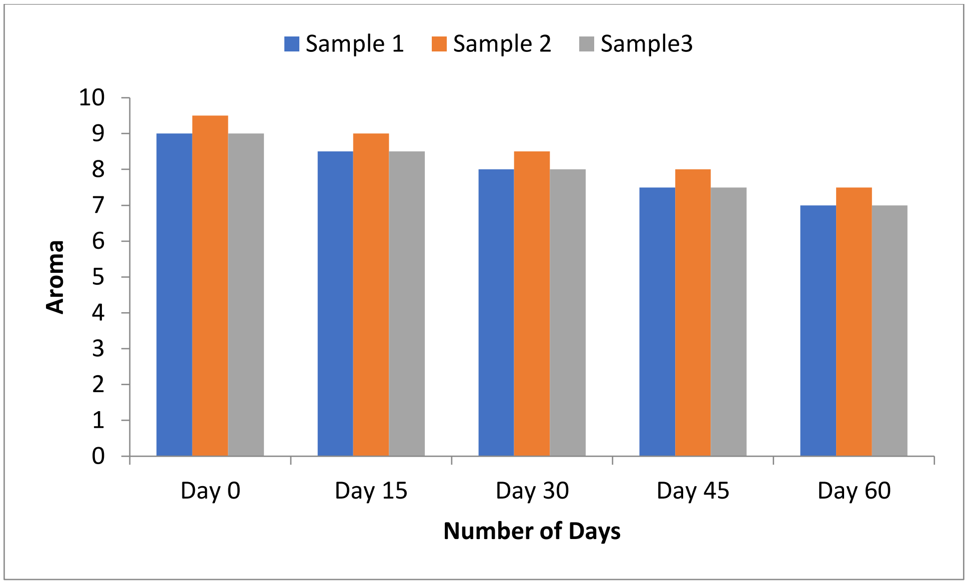

Figure -4.7 Aroma of ragi cookies

4.9 Flavor

The effect of packaging material, storage time and EFY powder on flavor is presented in figure 4.9. The flavor of cookies decreased slightly with increase in storage period.

Table 4.9 Flavor of ragi cookies

	Sample 1	**Sample 2**	**Sample3**
Day 0	9	9.5	9
Day 15	8.5	9	8.5
Day 30	8	8.5	8
Day 45	7.5	8	7.5
Day 60	7	7.5	7

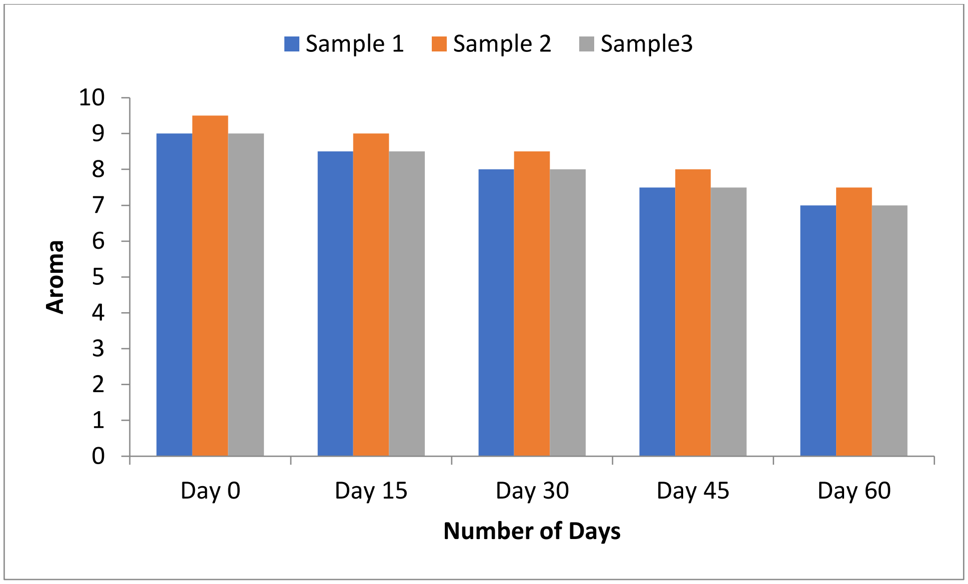

Figure - 4.8 Flavor of ragi cookies

4.10 Texture

The effect of packaging materials, storage period and EFY powder on texture of cookies is presented in Fig 4.10. There was a slight decrease in texture due to less moisture present packed ragi cookies. After 2 months of storage the score for texture of different samples are given below.

Table 4.10 Texture of ragi cookies

	Sample 1	Sample 2	Sample 3
Day 0	9	9.5	9
Day 15	8.5	9	8.5
Day 30	8	8.5	8
Day 45	7.5	8	7.5
Day 60	7	7.5	7

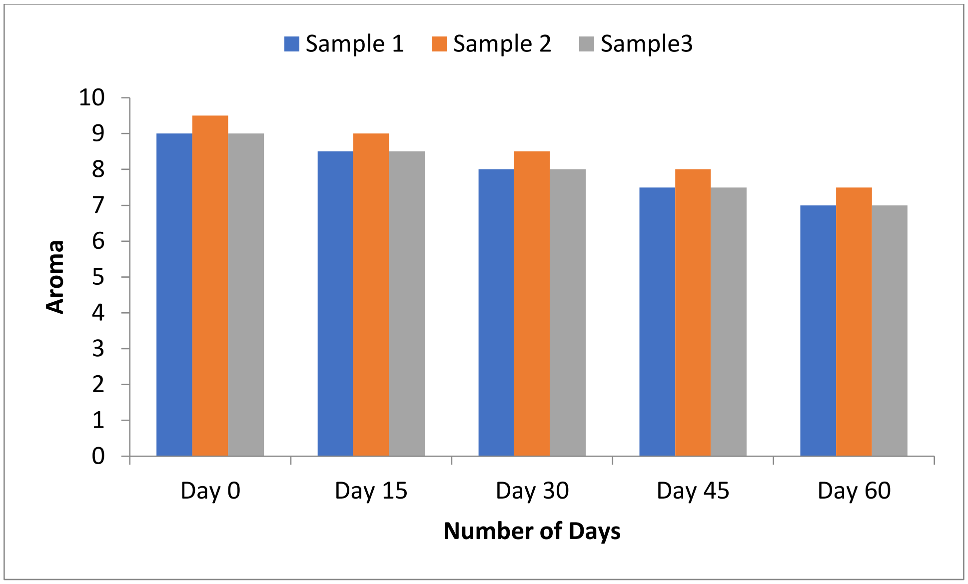

Figure - 4.9 Texture of ragi cookies

4.11 Appearance

The effect packaging materials, storage period and EFY powder on appearance of ragi cookies are presented in Fig 4.11. The highest score for appearance was obtained in Sample S3. There was a slight decrease inappearance score for storage of cookies.

Table4.11 Appearance of ragi cookies

	Sample 1	Sample 2	Sample3
Day 0	9	9.5	9
Day 15	8.5	9	8.5
Day 30	8	8.5	8
Day 45	7.5	8	7.5
Day 60	7	7.5	7

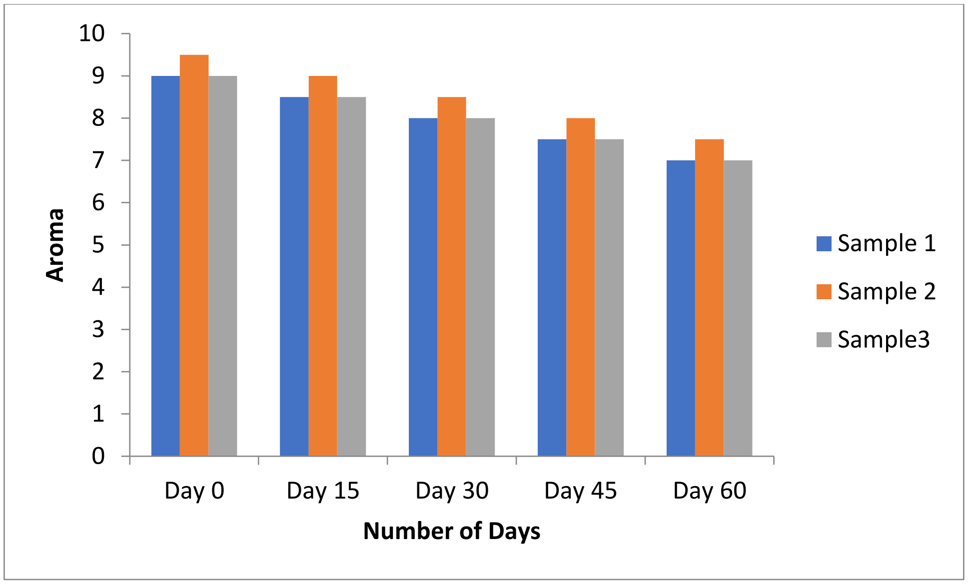

Figure:-4.10 Appearance of ragi cookies

4.12 Overall Acceptability

The effect of packaging materials, storage period EFY powder on appearance of ragi cookies is presented in Fig 4.12. The overall acceptability of cookies decreased slightly with increase in storage period.

Table4.12 Overall acceptability of ragi cookies

	Sample1	Sample2	Sample3
Day 0	8.5	8.5	9
Day 15	8	8	8.5
Day 30	7.5	7.5	8
Day 45	7	7	8
Day 60	6.5	7	7.5

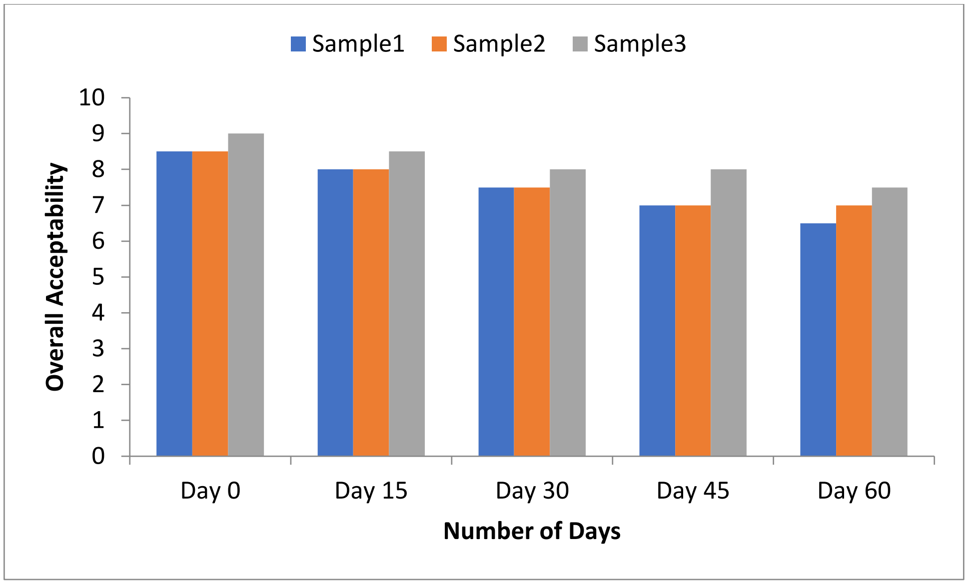

Figure - 4.11 Overall acceptability of ragi cookies

CHAPTER 5

SUMMARY AND CONCLUSION

During this project it was observed that when ragi cookies was incorporated with EFY powder there was increase in protein content and slight changes in fat content after 30days. Fat content was increased with storage but in adequate amount. The following conclusions were obtained.

- It was obtained that as we increased the content of EFY powder there was a huge increase in protein content and decrease in fat content and the developed product was ready to be served as proteinatious food.
- The observation also concluded that the product can be stored till 90 days for better sensory characteristics.
- The developed product is a proteinatious food which can be consumed on daily basis.
- The sensory analysis showed that due to addition of EFY, the color and the taste ratings were minimum. So by adding natural flavors and colors the product can be modified in a certain manner.

Future aspects of the research-

The value added ragi cookies can be further modified and tastier by adding natural flavors and colors in a certain proportion. It could serve as the healthiest food for which can be consumed on daily basis and can also be stored for long term. EFY if stored and processed in hygienic conditions can be used as space food. For the betterment of food, it can be mixed with other ingredients and after further testing it can be used as **Space Food.**

CHAPTER 6
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