PREPARATION OF TRADITIONAL MULTI GRAIN CHAKLI

Dissertation Report-1

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CERTIFICATE

This is to certify that Kirti Nehra has personally completed M.Sc. Dissertation-1 entitled '**STUDY ON PREPARATION OF TRADITIONAL MULTI GRAIN CHAKLI'** under my guidance and supervision. To the best of my knowledge, the present work is the result of her original investigation and study. No part of Dissertation-1 has ever been submitted for any other purpose at any university.

The project report is appropriate for the submission and partial fulfilment of the conditions for the evaluation leading to the award of Master of Food Science and Technology.

Signature of Supervisior

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DECLARATION

I hereby declare that the work presented in the Dissertation 1 entitled **'STUDY ON PREPARATION OF TRADITIONAL MULTI GRAIN CHAKLI'** is my own original work. The work has been carried out by me at School of Agriculture, Lovely Professional University, Phagwara, Punjab, India under the guidance of **Er. Jasleen Kaur Bhasin**, Assistant Professor (Food Technology) of School of Agriculture, Lovely Professional University, Phagwara, Punjab, India for the award of the degree of Master of Science in Food Technology.

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I certify that the above statement made by the student is correct to the best of my knowledge and belief.

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INTRODUCTION CHAPTER 1

The study was undertaken to develop a multigrain chakli using various combination of flours of various millets, pulses and cereals that include Sorghum, Finger millet, Pearl millet, oats, rice, Green gram dal and by using sesame seeds and flax seeds.

1.1 TRADITIONAL FOODS AND CONVENIENCE SNACK FOODS

Among the convenience foods present in the market, most of the market is belonging to the deep-fried snack food category. The origin of these fried food products can be traced back to the traditional practices of better preservation technique where fried food became choice due to their shelf stability *(Kumari and Prakash, 2009).*

Snack food represents a wide group of food products which are available in the market of the world. The large variety of snack food products are common in the Indian market. The snacks are the convenient foods which help in overcoming the short-term hunger. *(Tettweiller 1991).* The snack is defined as 'a light meal or food is eaten between regular meals.*' (Webster's New Ninth Collegiate Dictionary,1985).*

The term traditional foods generally refer to the foods which are traditional in nature, and the foods may have historical precedent with the country, region or a place. The traditional foods are basically confined to a country national dish, regional cuisine or a local cuisine. These traditional foods and beverages are passed through generations and these are the foods which are consumed and cultivated over a long period of time over generations. The traditional foods have the unique place in the dietary practices of a large group of population in different countries. these traditional foods are known for their unique texture and taste. Among all the traditional foods, snacks food products hold a significant share. India has a wide variety of traditional foods, among all the traditional foods of India, snacks have the maximum variety of products. In India, the specific snacks are prepared in each state. The special snacks from each of the states are made available across the country and they have already occupied the place in the daily dietaries of the population. *(Amruta Subhashrao Lohekar., 2014).*

1.2 CHAKLI

Chakli is one of the traditional foods of India. It is generally a traditional breakfast snack popular in India, the chakli is made during the Diwali festival and now it is available as ready to eat snack product which is prepared from sorghum. Chakli is delicious savories that are

mostly made at home and stored in airtight containers for eating as fancied and it is enjoyable, crisp, crunchy and satisfactory snack item. Chakli is exclusively traditional food of south India, but it is also prepared in western India but in a different version under the name of chakkali which is made using Chana dal and is sold in market *(Shakshi sharma., 2015)* chakli also known as murruku is also a popular snack in Sri Lanka, Fiji and elsewhere among the ethnic Indian population. *(Ramasamy Ravi et al ., 2011).*

The chakli or murukku is made traditionally with the mixture of black gram flour, rice flour, salt, and chili, asafotedia, ajwain and cumin added accordingly for flavoring purpose. The mixture is made into a batter and mechanically extruded into various shapes like the spiral, coiled or rolled into a ribbon-shaped or can also be shaped by hand. And then fried to the crisp. The chakli is traditionally enjoyed by the people for their taste and crisp texture.

Chakli is available in various shapes like spiral-shaped, pretzel-like the snack with a spiked or irregular surface. It is made typically by using flours of rice, Bengal gram, black gram, and sorghum. It has several variations, depending on the types and proportion of flours used. Murukku is a similar term used for snack item made without the usage of Bengal gram flour. This murukku is sometimes also called chakli.

1.2 ALTERNATIVE NAMES ASSOSIATIED WITH CHAKLI

Other names of chaklis commonly used in various states and regions of India include:

STATE/REGION	ALTERNATIVE NAME
Maharashtra (Marathi)	Chakali
Karnataka(kannada)	Chakkuli
Gujarat (Guajarati)	Chakri
Andhra Pradesh(Telegu)	Chakralu
Telangana (Telegu)	Jantikalu
Goa (Konkani)	Chakkuli or chakri

Sometimes murukku is also called as chakli as it is similar in preparation the only difference is Bengal gram flour is not added in murukku. In Indonesia variations of chakli and murukku and popularly known as Akar Kelapa, and particularly among Betawi.

1.4 GRAINS

The multigrain snack products are prepared by using two or more grains together. The principle lies in the fact that each grain has their own nutritional profile, hence combining two or more grains may add additional nutrients in the final product. Thus, the multigrain products provide a large number of nutrients which may not be sufficiently available through the consumption of single grain variety. Multigrain products not only provide nutrients they also provide a variety of phytochemicals, flavors and improve sensory and textural quality of the product. *(Arya et al., 2013).* The traditional preparation of chakli is a combination of cereal and pulses spices with or without the addition of and sesame or cumin seeds. The multi-nutrient chakli is made by using the combination of cereal and pulses and by incorporation of millets such as Sorghum, Pearl millet, Finger millet, oats with the addition of spices in appropriate ratios. And to improve the nutritional quality of the chakli sesame seeds and flax seeds are used in preparing the multi-nutrient chakli.

1.4.1 MILLETS

Millets are one among the types of cereals which majorly include Wheat, Rice, and Maize. These millets are also known as small grain cereal crops. They can grow in the stressful conditions where cereals grow but fail to give substantial yields. *(Adekunle, 2012).* Millets are classified along with Maize, Sorghum, and Coix *(Job's tears)* in the subfamily of grass known as Panicoideae. *(Yang et al., 2012).* Millets rank 6th in cereal crops according to world agricultural production. These are important drought-resistant plants and are also resistance towards diseases and agricultural pests. On comparison with cereals, they have short growing seasons and have good productivity under drought conditions. Millets are generally known for their small seed structure. The various varieties of millets include Pearl millet (Pennisetum glaucum), Finger millet (Eleusine coracana), Kodo millet (Paspalum setaceum), Proso millet (Penicum miliaceum), Foxtail millet (Setaria italic), Little millet (Panicum sumatrense), and Barnyard millet (Echinochloa utilis). They are also referred to coarse cereals along with maize (Zea mays), sorghum (Sorghum bicolor), oats (Avena sativa), and barley (Hordeum vulgare) *(Bouis 2000; Kaur and others 2012).* Millets are staple foods in many underdeveloped countries. The majority of the population in Africa depend on millets as they serve as the major

source of energy and protein. It is being stated that millets are highly nutritious and have medicinal functions. *(Obilana and Manyasa, 2002; Yang et al., 2012)*

1.4.2 SORGHUM

Sorghum (*Sorghum bicolor L.)* is most widely consumed cereal crop after Wheat and Rice. Among the millets, it's called as great millet and commonly known as Jowar. It is majorly grown in Maharashtra and southern parts of India which include states like Karnataka and Andhra Pradesh. Other states which cultivate Sorghum are Madhya Pradesh, Gujarat, and Rajasthan. Among all these states which cultivate Sorghum, the three states that are Maharashtra, Andhra Pradesh and Karnataka together account for 80% of the total Indian production of Sorghum.

India stands the third position in the production of Sorghum in the world with 5.54 million tons production in 2013-14 and almost entire production of Sorghum (95 %) in the country comes from those three states. Millets Sorghum and pulses are the traditional staple food grains for a majority of the household consumption in the rural areas of the country. *(Dayakar Rao et al., 2007).* In rural and remote areas of Maharashtra, the per capita annual consumption of Sorghum is around 70 kg, which almost accounts for half of the per capita consumption of all the cereals consumed. *(Parthasarathy Rao et al., 2010).*

Sorghum belongs to family Germaine. It is considered as coarse grain due to the presence of outer fibrous bran of the seed. Sorghum is rich in leucine and poor in lysine content. Sorghum is a good source of calories, protein, and minerals.

1.4.1.1 NUTRITIONAL VALUE

Nutritional importance was sorghum was given for 100g of grains (*Chavan and Salunkhe, 1984)*

Components	Value for 100g of grain
Energy	349 Kcal
Proteins	10.4g
Fat	1.9g
Carbohydrates	72.6g
Calcium	25mg
Iron	4.1mg
Thiamine	0.37mg
Riboflavin	0.13mg

Sorghum has more protein continent when compared to Maize and have less fat content and have the same amount of carbohydrates are present. The grains of Sorghum are good sources of calcium, magnesium, potassium, and iron. The Sorghum protein is superior to that of Wheat protein in accordance with digestibility and biological value. The grains of Sorghum is totally free from gluten and contain more of micronutrients and fiber. *(Klopfenstein and Hoseney, 1995).* The major carbohydrates are starch present in the grains. The other carbohydrates present in grains of Sorghum are simple sugars, hemicellulose, and cellulose. *(Miller and Burns, 1970).*

The lipids of Sorghum are mostly consisting of triglycerides, which are rich in the unsaturated fatty acids, oleic and linolenic, their percentage being 33 and 7 percentage respectively *(Salumkhe et al., 1977).*

The nutritive quality of Sorghum can be improved by malting, fermentation and by mixing of various flours of other cereals grains or pulses. *(Kazanas and Fields,1981 and Au and Fields,1981).* Malting or sprouting of Sorghum can improve the nutritional quality in terms of increased soluble proteins, free amino acids, reducing sugars and digestibility of proteins and starch. The higher proportions of dietary fibers of Sorghum grain have many advantages such as nutritional, digestive and physiological benefits such as hypoglycemic effects, hypo-cholesterolemic effects, lowering incidence of colon cancer, constipation etc. *(Novellie,1977).*

1.4.2 Finger Millet

Finger millet *(Eleusine coracana)* is an indigenous minor millet it is most commonly known as Ragi. It is one of the important staple food in the eastern and central African and in most of the parts of India. *(Amruta Subhashrao Lohekar., 2014)* It is a native crop of Ethiopia, but now it is extensively grown in India and African countries. It supplies a major source of calories and protein to the large segment of the population in this country *(Ekta Singh and Sarita., 2016).* Figure millet is one of the oldest millet grain crops in India. *(Achaya, 2009)* the size of the Finger millet is smaller in size, compared to a majority of cereals and are of globular shaped with red to brick red color.

Finger millet is widely cultivated in tropical and sub-tropical regions of the world, it is grown in the countries like Africa, Sri Lanka, China, Malaysia, Japan, and India. In India, it is mainly grown in Uttar Pradesh, Karnataka, Maharashtra, Himachal Pradesh, Andhra Pradesh, Bihar, Orissa, and Gujarat. The production of Finger millet ranks sixth after the production of Wheat, Rice, Maize, Sorghum and Pearl millet in India. *(Vanithasri, 2012).*

The importance of Ragi (Finger Millet) in nutraceutical point of view is that it has a high content of proteins, calcium, carbohydrates, dietary fibers, minerals, phytates, tannins, phenolic compounds and trypsin inhibitory factors. *(Dinesh Chandra et al., 2016).* The grains of Finger millet is the richest source of calcium, when compared with other food grains it is 10 folds higher in calcium content. The protein in Finger millet grains is well balanced, and it contains more lysine, methionine, threonine, and valine. The iodine content in the Finger millet is highest among all the food grains. *(Gopalan et al., 2004).*

1.4.2.1 Nutritive Value

Ragi is also well known for its health benefits which include properties like it is antidiabetic, anti-tumorigenic, anti-diarrheal, antiulcer, anti-inflammatory, atherosclerogenic effects, antioxidant and anti-microbial properties. *(Dinesh Chandra et al., 2016).*

The nutritive value for 100gs of finger millet grain is given as *(Ekta Singh and Sarita., 2016)*

Components	Value for 100g of Grains
Energy	336 Kcal
Protein	7.7 g
Fats	1.5 g
Carbohydrates	72.6 g
Calcium	350 mg
Iron	3.9 mg
Thiamine	0.42 mg
Riboflavin	0.19 mg
Crude Fibre	3.6 g

There are various products which are made using Finger millet and those products include porridges, laddu, nippattu, maldi, annam, murukul, karappawosa, sangatti and *roti (Vanithasri et al., 2012).* At present, it is also used in the formulation and preparation of products like biscuits, cookies, noodles, puddings, vermicelli, pancakes, bread, papad, Satu (malt), malt drinks, RTE puffed ragi mix, composite flour, millet based diabetic mix *(Chilkawar Pallavi Marotirao ., 2017).*

1.4.3 Pearl Millet

Pearl millet *(Pennisetum glaucum (L) R.Br.)* is widely grown crop in Africa and India. It has got a number of advantages that this crop is made the staple cereal crop in subsistence and low-resource agriculture in hot and semi-arid reigns of West Africa, Sahel. In India, it is mostly grown in north-western India and Rajasthan. *(Kassam & Kowal et al., 1975).*

Common names of Pearl Millet In India

NAME	LANGUAGE
Bajra	Hindi
Kamboo	Tamil & Malayalam
Sajjalu	Telugu
Bajri	Marathi & Gujarati
Bajara	Bengali, oriya, Punjabi & urdu

Bajara is superior to sorghum as human food and at least equals to maize in value as a feed grain. The bajara has got many medicinal advantages and benefits it helps fighting anaemia as it has high iron content and increases the haemoglobin content, it helps in dealing with constipation as it is a good source of fiber and it also helps in dealing with diabetics as it has a low glycaemic index. Pearl millet is also recommended for curing of stomach ulcers in most of the people suffering. The reason for ulcers is excess acidity in the stomach. Pearl millet is one of the few foods that have the ability to turn the stomach alkaline and reduces ulcers. The lignin and phytonutrients in the millet act as strong antioxidants and thus preventing heart diseases. The Pearl millet helps in the weight loss as it is high in fiber content and retention time of the food in gut is increased that means it takes longer time for the grain to move from the stomach to the intestine and hence this causes the Pearl millet satiates hunger for long period of the time and thus lowers the overall consumption of food. *(Shweta Malik., 2015).*

1.4.3.1 Nutritive Value

The nutritive value is given for 200gms of the grains.

Components	Value for 200g of Grains
Energy	361 Kcal
Protein	22g
Fats	8.4g
Carbohydrates	146g
Calcium	16mg
Iron	6 mg
Thiamine	842 mcg
Riboflavin	580 mcg
Dietary Fibre	17 g

The major food products prepared using the Pearl millet are porridges, flatbread either fermented or non-fermented, other products include couscous, boiled rice like preparations, snack blends with legumes flours, and non- fermented and fermented beverages are prepared using pearl millet in various countries.

1.5 NUTRITIONAL BENEFITS OF MILLETS:

Sorghum and millets which include Pearl, Proso, Finger, Kodo, Foxtail, Little and Barnyard millet are the most important and staple foods of the majority of the population worldwide. These crops require less rainfall and can grow in less fertile soil so has greater importance toward the sustainable agriculture and food security. The consumptions of Millets and Sorghum are primarily restricted to the animal feeds in the developed countries and in majorities of the developing countries it is used for human consumption. Nutrition of the millets is comparable to the coarse cereals and they serve as good source of micronutrients, proteins, and Phyto-chemicals. *(Saleh et al., 2013).*

Most of the millets and sorghum have 10% protein, 3.5% lipids, finger millet contains 12-16% protein and 2-5% lipids. They serve as good source of vitamins and minerals. The prolamin is the dominant protein present in the sorghum it is having a special feature of decreasing the digestibility on cooking whereas, the amino acids profile is remarkable in the millets. The Sorghum protein is less digestible in comparison with cereal proteins, this feature of the Sorghum protein can be beneficial to some of the dietary groups. The fewer cross-linked prolamins, present in Millets can be an additional factor which can increase the digestibility of the Millet proteins. *(B. Dayakar Rao et al., 2017).*

The naked caryopsis of the Finger millet having brick red colored seed coat is used in various forms like a whole meal in traditional recipes in the making of roti, muddle, and thin porridge generally known as ambali.

The consumption of Millets as whole grain supplies nutrients such as minerals, phenolic compounds, dietary fibers, and vitamins which are concentrated in the outer layers of the grains or in the bran and offer their nutritional and health benefits. *(Antony et al., 1996).*

The millets are a good source of essential amino acids when compared to Maize. The Pearl millet has higher niacin content than all other cereals. The proteins present in the Finger millet are unique as they contain sulfur-rich amino acids. The small millets are very much more nutritious in comparison with the cereals. Millets are a good source of phosphorous iron and calcium, among all the millets finger millet is the rich source of calcium (300-350/100g). *(B. Dayakar Rao et al., 2017).*

1.6 Health benefits of millets

The various studies were carried on the potential health benefits of millets revealed that the consumption of millets has reduced heart diseases, improves digestive systems, protects from diabetes, lower the risk of cancer, detoxifies the body, increases immunity in respiratory health, increases energy levels and improves muscular and neural systems and also protects against several degenerative diseases which include metabolic syndrome and Parkinson's disease *(Manach et al., 2005; Scalbert et al., 2005; Chandrasekara and Shahidi, 2012).* The health benefits of millets are due to the presence of nutrients which include resistant starch, lipids, oligosaccharides, and antioxidants such as phenolic acids, avenanthramides, flavonoids, lignans, and phytosterols. *(Miller, 2001; Edge et al., 2005).*

The Major health benefits of millets include:

CARDIOVASCULAR DISEASES

The millets are the rich source of magnesium and potassium which helps in reducing blood pressure and risk of heat strokes. And helps in maintenance of the blood pressure by keeping it low by acting as a vasodilator. The millets also have plant lignans which can convert the animal lignans in present of the microflora present in the gut and also protect against certain heart diseases. *(Dayakar Rao et al., 2017).*

Diabetes Mellitus

It is a chronic metabolic disease which is identified by hyperglycemia with alterations in the metabolism of carbohydrates, lipids, and proteins. It is one of the most common endocrine disorder which can be either due to deficient insulin production (Type 1) or can be resulted due to the combined action of resistance to insulin action and the insulin- secretory response (Type 2). *(Saleh et al., 2013).* The millets help in preventing diabetes as they on consumption provide a good amount of magnesium which increases the efficiency of the glucose receptors and insulin receptors in the body. The consumption of Finger millet has shown the reduction of the glycaemic index due to the presence of high percentage of dietary fiber. *(Kumari and Sumathi, 2002).*

Gastrointestinal Disorders

The fiber content in the millets helps in eliminating disorders like constipation, excess gas, bloating, and cramping. (Catassi and Fasano, 2008). The millets can replace the cereals like

Wheat which are responsible for celiac disease. This celiac disease is an Immune-mediated enteropathies disease which is usually triggered by the ingestion of the gluten. *(Catassi and Fasano, 2008).* These millets lack this gluten protein hence can be provided in the diets of the patient's suffering from celiac or gluten intolerance. The snacks foods and beverages were prepared using gluten-free grains to meet the increasing demands for the gluten-free products in the markets. *(Taylor et al., 2006).*

Cancer

Millets are the rich source of phenolic acids, tannins, and phytates *(Thompson, 1993).* In animals, these nutrients help in the reduction of risk of the colon and breast cancer (*Graf and Eaton, 1990).* The fibers and phenolic contents present in the Millets and Sorghum have attributed to reduced the incidence of oesophageal cancer than consuming Maize and Wheat *(Van Rensburg, 1981).* It was analyzed from the research revealed that the fibers help in preventing the breast cancer in women.

1.7 Various recipes of millets

The various recipes are enlisted here which were made from incorporation small millets.

Breakfast food: Idli, Dosa, Idiappam, Rotti, Pittu, Upma, Adai, Porridge, Khakra, Paniyaram and Chappathi.

Sweets: Halwa, sweat kolukattai, Adhirasam, Kesari, Nutritious ball, and Kheer.

Snacks: Vadai, Pakoda, Ribbon pakoda, Omapodi, Murukku, Thattu vadai, Hot kolukattai and Vadagam.

Flaked and Popped products

Pasta products: vermicelli, noodles, macaroni etc

Value-added product flakes - aval uppma, kitchadi, payasam, masala flakes, boli, sweet balls, lemon bath, tamarind bath and tomato bath.

Value-added products from popped millets - uppma, bhelpuri, masala corn, cheeian.

Bakery products: bread, cake, cookies, soup sticks, buns, and Khari.

PROBLEM BACKGROUND CHAPTER 2

The consumers demand healthy, low fat, organic, fiber-rich and low calories food. The consumers want a single food to serve all the benefits and they want it to be tasty and have good sensory properties. Most of the population enjoy the traditional foods which include chakli, murukku, seviya, kheer etc. The chakli is most commonly consumed all over India and it is mostly prepared in the home and sold in the local market, the problem faced by the traditional foods like chakli are under the category of deep fried snack products. so, they are having high-fat content, they are high in calories and low on nutritional value. So, the multi-nutrient chakli will serve as the product which will fulfil all the demands of the consumer and will also help in minting the low calories diet which can be enjoyed by the people on treatment with obesity and as the present scenario the people are also suffering from gluten allergies, and couldn't enjoy the traditional products, the multi-nutrient chakli can be one of the substitutes for them.

OBJECTIVES CHAPTER 3

2.1 To standardise and optimize the recipe of RTE chakli by incorporating various underutilised grains.

2.2 To study the nutritional, physico-chemical properties and sensory attributes of the chakli.

2.3 To carry out self-life and storage studies on the chakli.

4.1 Shelf Life study of Ready to Eat food products

K*aruppasamy et al.,* in 2010 developed a millet-based convenience mix and carried out shelf life studies on the multipurpose snack mix product. The study revealed that the food products like laddu, uthiripittu, kuzhapitu and roti mixes were highly accepted organoleptically and scored high after the end of the shelf life period(90days). The microbial count of the multi propose snack mix was observed to be minimum at the initial stage (2x10-4) and after the storage limit (90days) the count of the microorganisms in the mix was found to be in safer limits. (7.0x10-4) and during the storage period the studies revealed that there was an increase in the moisture content (increased up to 0.87%) and decrease in the protein content (decrease up to 0.84%) reducing sugars also increased (0.65%) and decrease in total sugars (0.89%). The studies also stated that there is no significant difference was observed in mineral content and ash content of the instant mix. The studies concluded that Sorghum and Maize sooji is highly nutritious and were low in cost and it can be used for the preparation of highly nutritious products like laddu, roti, uthiripittu, kuzhapittu after suitable processing and the product have a good shelf life at ambient conditions.

4.2 Analysis of nutritional Quality and Sensory Evaluation

S*.D. Patekar et al.,* (2017) the investigation was carried to incorporate malted Finger millet flour at different levels to make chakli by the standardization of recipe and study was the effect on nutritional composition, sensory and storage characteristics. After conducting different experiments on sensory and nutritional quality it was found that protein content varies in the range from 11.20 to 14.75 % the fat ranges from 26.49 to 30.13 % the mineral composition which has calcium content from 11.20 to 114.75 % similarly, iron 1.93 to 2.35 mg per 100 gms and phosphorus content was and 144.05 to 158.01 mg per 100 gms. Hence it was concluded that the chakli made was nutritionally balanced and have nutraceutical properties.

Z*eblish Ali et al., (2016)* the investigation was carried out to determine the nutritional composition and antioxidant activity of chakli incorporated with dehydrated Moringa olifere and Solanum nigrum leaves. In this study chakli was prepared using Besan (Solanum nigrum) and Moringa oliefera at 90:5:5%, 85:5:10% and 85:10:5% and used as T1, T2 and T3 respectively and the control was maintained using basic ingredients. The sensory analysis of the products was conducted using 9 points hedonic scale and by using ANOVA the data

obtained from the sensory analysis was obtained. The studies also stated that the nutritional analysis was carried out on the best treatment from the sensory evaluation. The analysis was done for ash minerals (iron and calcium) vitamin c polyphenols, β-carotene etc were carried out. According to organoleptic properties treatment (T2) made with Besan, Moringa olieofera and Solanum nigrum in the ratio 85:10:5 and with dehydrated leaves mixture were accepted when compared to all other treatments. The results show a significant difference between T0 and best treatment T2 in context with moisture, ash, carbohydrates, energy etc. Were calculated and the calculated value of 't' was found to be greater than tabulated value 't' 4.303 which denotes that T2 is better in comparison with T0.

S*asikanth Sarangam et al.*, (April 2015), the investigation was carried out to develop a low-fat multigrain murukku having low protein and mineral content and the fat content was found to be high as the product was deep fat fried. The variable samples were prepared using Bengal gram, Green gram, and Black gram flours. From the studies it was observed that the control and variable murukku samples which were deep fried, and oven baked in these samples the fat content varied with baking and the uptake of oil was reduced by 46.4% and there was increase in the protein content by 40.23% with the use of Bengal gram, black gram, green gram flours at 8% incorporation of each flour. It was observed that the content of mineral is more in the variable sample. There was an increase in antioxidant activity in the variable sample. The modification of simple traditional recipes and changing the traditional deep-frying by oven baking has increased the nutritional quality, by increasing the protein content and mineral content, decrease in the fat content. The studies on the shelf life of the product revealed all the murukku samples were found to be non- hygroscopic and can be stored for 3 months without any quality loss.

H*oitnkim Singson et al.,* (2014) documented 56 recipes of chakli and evaluated physio-chemical and sensory attributes of commercial chakli. In the documentation the data from various sources like cookery books, magazines etc, and revealed that the common ingredients used in most of the preparation of chakli are rice and black gram. It was also observed that there were wide variations in processing and ingredients of chakli. The investigation was carried out in the local markets for the evaluation of commercial chakli for the fat content and sensory attributes. In the studies, it was stated that the fat content varied from 17.6 to 42.3 % with the mean of 31.71%, and there was a significant difference between the samples. The

studies also show that 52, 43, 39, 35, and 34% of chakli were considered as like slightly and like moderately with respect to appearance, color, texture, taste, and overall acceptability respectively with a slight difference between the samples. the studies also concluded commercial chakli sample varied greatly in terms of quality.

***S**hahzad Hussain et al.,* (2008) the investigation was undertaken to study on the chemical composition and functional properties of roasted and non-roasted full fat or partially defeated flax seed flour according to the studies it was found that there is a significant increase in the crude protein, crude fiber, ash and mineral contents in the partially defatted flaxseed flour. Roasting of flax seeds effectively reduces the anti-nutritional factors like cyanogenic glycosides content, thus it was concluded that the replacement of roasted partially defatted flaxseed flour up to a level of 16% supplementation in whole wheat flour was found acceptable regarding sensory attributes.

***R**amasamy Ravi et al.,* (2011), the study was conducted to examine the quality parameters of commercially available deep-fried snack, murukku. is the murukku was made up of rice flour and black gram flour. 8 samples of murukku were collected and were analyzed for moisture, oil content CIE instrumental color, instrumental texture measurements, Aroma fingerprinting by electronic nose and sensory quality. Quantitative descriptive analysis and results showed that the sample A was widely accepted than the sample D. From the studies the results were reported as significant variations were observed in moisture content 2.2-3.35%, and oil content 30.10-34.61%. The variation was also observed in the textural parameters of the chakli. The studies concluded that large variation was observed among the market samples for aroma analysis the technique of fingerprinting was useful. Descriptive sensory profiling coupled with principal component analysis could be used to study the interrelationship among the sensory, instrumental and chemical parameters. It is important to produce food products with desirable sensory attributes and with consistent quality.

***H**oitnkim Singson et al.,* (2012) conducted studies on "physicochemical and sensory evaluation of commercial chakli and development of Little millet (Panicum sumatrense) chakli". In his studies, it was stated that chakli is one of the most consuming Indian snack product and little millet is one of the cereal grain which is high in nutrient content. The documentation was done, and recipes were collected, according to the documentation the chakli were made up of a majority by using rice (86%) and black gram (28%) and little millet was least used (2%). the

evaluation of commercial chakli has revealed that fat content and sensory acceptability varied among the samples. The studies were carried out for the optimization of the processing method of little millet grains and other ingredients for the preparation of good quality chakli. The sensory and acceptance test was done at each level of optimization of the process and fat content was also analyzed at every step. the chakli was made using puffed Bengal gram and little millet in the ratio of 1:5 with 5% heated oil and ajwain and asafoetida and was fried at 180°c for 4 min. the little millet chakli was compared with rice chakli and it was found that nutrients and crude fiber were more in little millet chakli than of the rice chakli. The storage of little millet was done for 2 months and it had acceptable organoleptic properties.

L*eena Sebastian et al.,* (2005) studied the quality characteristics of ragi *(Eleusine coracana)* incorporated in chakli. In the studies the ragi was incorporated at different levels (5,15&25%) to a snack item chakli, the studies were conducted to study the effects on fat absorption, sensory and storage parameters. The studies also state that the incorporation of dry heat treated and untreated ragi flour resulted in poor sensory properties and decline in the rating was observed and adverse effects were observed at the high levels of incorporation. The samples which were prepared incorporated with gelatinized ragi flour (5%) the higher ratings were observed for overall quality when compared to the control sample. The storage studies reveal that on the 0th day da the free fatty acid content was very low, and it was observed that there was an increase in storage for 4 weeks. The studies concluded that from the results the incorporation of a high amount of ragi in the preparation of chakli the samples absorbed less fat but were not accepted on the sensory attributes they were rated very low. The incorporation of ragi flour on 5% level was effective and had opposite effect and gelatinization given as a pre-treatment to the flour was found to improve the quality of the product.

B*. Nagmani and Jamuna Prakash* (1997) studied on functional properties of thermally treated legumes flours. The studies were carried on functional properties of thermally treated and decorticated flours of 4 different legumes that were Bengal gram (Cicer criterium), Black gram (Phaseolus mungo Roxb), Green gram (Phaseolus aureus Roxb) and lentils (Lens esculenta) were studied. The four samples of legume flour with moisture content 3.2,3.3,1.3 and 5.0 % respectively were subjected to dry heat treatment in a covered vessel in a pressure cooker. The controls were untreated flours. The studies resulted that thermal treatment lowered nitrogen solubility of all the flours and increased water absorption capacities in Bengal gram (146), black gram (451) and lentils (206) and the values for controls were 138,441 and 180/ 100g of

flours respectively. The thermally treated flours of Bengal gram (242) and black gram (292) showed decreased fat absorption capacities when compared to control samples of Bengal gram (298) and black gram (303) per 100 gms of flour. The investigation was carried out by preparation of chakli and seviya by using two of the legumes. The complete analysis was done on the products prepared from the thermally treated flours. And it was observed that they absorbed less fat. The sensory scores for appearance, texture, flavour and overall quality obtained by seviya prepared by control are 6.04, 6.20, 5.98 and 6.40 respectively and scores obtained by the seviya prepared from the thermally treated flours are 5.74,5.78,5.70 and 5.68 respectively and for the chakli prepared with thermally treated flour was observed significantly lower score of 6.08,5.2,5.42 and 5.88 and in the control, it was observed to be 6.78,6.68,6.68 and 6.88 respectively.

4.3. STUDY ON THE DEVELOPMENT OF CHACKLI

J*agtap Yogesh Kisan* (2015) carried out studies to develop a protocol for the preparation of niche products like chakli and shankarpalli which were prepared using sorghum. The studies were also carried out for the analysis of sorghum grains and products prepared (chakli and shankarpalli). In the studies the preparation of chakli and shankarpalli was prepared using five verities and two hybrids of sorghum. From the studies it was found that the crude protein content of the sorghum grain was 8.25 to 9.45%, and for chakli it was 13.64 to 18.28% and for shankarpalli it was 9.4 to 11.15%. the total sugar content in the grain, chakli and Shankarpalli was found to be (1.62-1.95%), (2.49-3.75%) and (33.30-34.25%) respectively. The crude fiber content was found to be in the sorghum grain 2.70-3.25%, in chakli it was 2.15-3.75% and in shankarpalli it was found to be 2.80-4.35%. The fat content in the grain it was observed to be 1.25-1.66%, in the chakli it was 37.24-40.02 % and in shankarpalli it was 26.95-33.73%. the ash content was analysed and in the sorghum grain it was 4.01-4.45%, in chakli it was 2.22-3.34% and in shankarpalli it was 1.30-1.58%. the preliminary studies revealed that the 50% addition of sorghum flour for preparation of chakli and shankarpalli was found to be most suitable. The studies on organoleptic properties of chakli and shankarpalli were evaluated on the basic of colour, texture, taste, appearance, flavour and overall quality on the hedonic scale of 9 points. The studies concluded that the chakli prepared from the sorghum of the variety Phule vasudha and Phule revati were best ones when compared to other verities and hybrid of sorghum on the basis of nutritional composition and organoleptic properties.

4.3 Analysis Of physico Chemical Properties of millets

N*oha.A Mohammed et al.,* (2014) investigated on "Nutritional evaluation of Sorghum Flour (Sorghum bicolor L. Moench) during processing of injera." And observed that the proximate composition of the raw sorghum flour and fermented sorghum flour and it was also determined injera i.e. unleavened thick bread. Studies reveals that the raw sorghum flours protein, ash, fat, fiber, carbohydrates were estimated to be 12.25%, 1.75%, 4.24%, 1.71% and 74.68% respectively and that of fermented sorghum flour protein, ash, fat, fiber, carbohydrates were estimated to be 10.07%, 1.65%, 3.93%, 1.82% and 75.36% respectively. the injera prepared from the fermented flour had low protein content and had high fiber content. The polyphenol content was reduced in the fermented flour which was found to be 6.64mg/100g of polyphenols, 247.92mg/100g of phytates and 0.18mg/100g of tannins and the raw sorghum flour had 8.10mg/100g of polyphenols, 317.65mg/100g of phytates and 0.18mg/100gm of tannins. The fermented flour was also rich in calcium, iron and copper. The digestibility of the product was also increased as there were low amounts of anti-nutrients.

S*amuel Ayofemi Olalekan* Adeyeye (2016) studies on "Assessment of quality and sensory properties of sorghum–wheat flour cookies." He has carried out comparative studies on sensory qualities chemical and physicochemical parameters of the flours and cookies. The preparation of cookies was done using wheat flour incorporated with the 5-50% of the sorghum flour. This resulted in increased moisture content, crude fiber, ash, fat, and protein content. The proximate analysis of wheat was moisture 8.64%, ash 1.57%, crude fiber 1.42%, fat 2.29%, protein 8.48%, starch 76.92% and sugar 1.68% and sorghum flour had moisture 10.28%, ash 2.41%, crude fiber 2.32%, fat 3.81%, protein 10.72%, starch 70.38%, and sugar 1.16%. The cookies prepared using composite flour at various rate of incorporation and analysed for their moisture, ash, crude fiber, fat, protein, starch, and sugars and they ranged from 8.76% to 9.16%, 1.61% to 1.88%, 1.48% to 1.79%, 2.36% to 2.74%, 8.54% to 9.26%, 75.67% to 72.94% and 1.63% to 1.32%. There was also decrease in calorific value of the cookies from 489 to 421 cal/100g.The sensory evaluation resulted there was a significant change in the color, texture, taste and overall acceptability.

4.4 Development and shelf-life evaluation of pearl millet based upma dry mix

S*. Balasubramanian et al.,* (2012) carried out studies on development and shelf-life evaluation of pearl millet based upma dry mix. He prepared the mix using the pearl millet semolina. The hydrothermal treatments were given to the grains before the preparation of the samolena as to

reduce the ANFs and to inactivate the lipase activity. He also conducted CCRD with three different ingredients like Vanaspati, citric acid and water for rehydration were used for the designing of the experiment. The experiments were carried out on the sensory and rehydration. The mix was examined for the peroxide value, thiobarburitic acid value free fatty acids text and also sensory analysis to check the quality during the storage and the studies revealed that the upma mix was stable for 6 months at ambient conditions (20-35°C) in polyethylene pouches.

MATERIALS AND METHODS CHAPTER 5

5.1 PROCUREMENT OF RAW MATERIAL

The current study on preparation of traditional multi-grain chakli was planned to use various combination of cereal pulse millets and sesame/flax seeds which were brought from the local supermarket market of Phagwara and Jalandhar in Punjab, India. The flour of black gram was made by giving roasting as a pre-treatment to the grains and then ground into fine flour. The flours of Rice, Sorghum, Finger millet and Pearl millet were used directly and the oats used in thht'e preparation of the chakli were in the form of oatmeal of the brand Quaker. These oatmeals were also roasted and then grounded into the flour. The spices, salt and rice bran oil used in the preparation of the chakli were also brought from the local grocery stores at Jalandhar and Phagwara in Punjab India.

5.2 FORMULATION OF CHAKLI

The chakli was prepared by the two methods which included the deep frying and baking of chakli. The deep fried chakli was prepared by the method described by Mr. Jagtap Yogesh Kisan in his thesis "PREPARATION OF NICHE PRODUCTS FROM SORGHUM (CHAKALI AND SHANKARPALI)" in the year 2015. The baked chakli was prepared by the method given by Sana Saiyed and Rupali Sengupta in their paper "MULTIGRAIN BAKED CHAKLI FOR OBESITY" in the year 2014. The ingredients and procedure were slightly modified. The chakli was made using various combinations of the Rice, Black gram, Finger millet, Sorghum, Pearl millet, Oats Flax and Sesame seeds along with the addition of the spices and salt as per requirements.

5.2.1 FLOW SHEET FOR PREPARATION OF DEEP FRIED CHAKLI

Millets, Rice, Pulses

↓

Cleaning

↓

Roasting

(upto light brown colour)

↓

Grinding

↓

Mixing flour with ingredient and water

(salt, chilli powder, cumin and spices etc.,)

↓

Dough preparation

↓

Filling in the dye

↓

Preparation of chakali

↓

Frying (Deep fat frying)

↓

Cooling

↓

Storage

5.2.2 FLOW SHEET FOR PREPARATION OF BAKED CHAKLI

Roast all the Dals and sesame seeds

↓

Grind them all together,

↓

Add Rice flour to it, Add olive oil and mix well

↓

Add chilli flakes. Add Roasted sesame seeds

↓

Add salt, chilli powder, dhanya powder, chat masala

↓

Make fine dough and make it in chakli form with the help of chakli maker

↓

Bake it at 180℃ in an Oven for 10-15 mins

5.3 PHYSIOCHEMICAL ANALYSIS:

5.3.1 Determination of Moisture Content

The moisture content of the sample was estimated by oven drying method (A.O.A.C., 2005). The sample was taken in triplicates. The 5gms of a sample was added to each bottle accurately (previously heated to 90°c to 100°c and cooled in a desiccator). The bottles contacting sample were loosely covered with lids and transferred to the oven and were heated at 105°c for 3 hours. After 3 hours, bottles were removed from the oven and allowed to cool in the desiccator and where weighed accurately. Then again bottles were returned to the oven for 1-hour and weighed. This process was repeated until the constant weight was observed. The moisture content of the sample can be calculated using the formula

$$\text{Moisture content of sample (\%)} = \frac{W_1 - W_2}{W_1} \times 100$$

Where,

W_1 = initial weight of bottle with sample before drying.

W_2= final weight of the sample after drying.

5.2 Estimation of Total Minerals

The total mineral content of the sample was determined by the ashing method (A.O.A.C., 2005). Set the temperature of muffle furnace to 600°c and heat the empty crucible for 1 hour and transfer into a desiccator and let them cool to room temperature. Then take the weight of the crucible as (W1). Weigh about 2-5gms of the sample into the pre-weighed crucible and take the weight again (W2). Heat the crucible cautiously at low flame until the materials begin to char and continue heating till the charring is complete. After charring transfer the crucible to the preheated muffle furnace (550-600°c), incinerate the sample for 4-6 hours until ash of white or light grey is obtained. Transfer the crucible into a desiccator and let them cool to room temperature and weight (W3). Repeat the procedure until two consecutive readings are obtained the same. The total mineral content of the sample was calculated by using the formula,

$$\text{Percentage of ash in the sample (\%)} = \frac{W_3 - W_1}{W_2 - W_1} \times 100$$

where,

W_1 = weight of the empty crucible

W_2 = weight of the crucible with sample

W_3 = weight of the crucible with ash

5.3 Determination of Protein Content

The protein content of the given sample was determined by micro- Kjeldahl method (A.O.A.C., 1990). The powdered sample was taken and 200mg of the sample is accurately weighed and transferred into digestion flask to which catalyst mixture and thoroughly mixed the sample. Then concentrated sulphuric acid and hydrogen peroxide are added carefully and the sample was digested in digestion chamber. The digestion of the sample is continued until the sample became colorless and clear. Then the flask was allowed to cool and to dissolve the solids the water is added to the flask. After cooling, the contents were added to volumetric flasks. The digestion flask was washed 3-4 times and volume was made up to 50ml in the volumetric flask. The boric acid solution was pipetted into a beaker and 6-8 drops of the mixed indicator were added. the beaker was placed under condenser of distillation assembly.ml of the digest was pipetted into distillation flask and 10 ml of sodium hydroxide is added and mixed thoroughly. This process was done till the 50ml of the distillate was obtained and then the tip of the condenser was washed to collect the ammonia and confirmation of the distillation was made with the litmus paper. The distillate collected was then titrated with 0.02N Standard

Hydrochloric acid. the color changes from pinkish red to bluish green and that the end point of the titration. Simultaneously, blank titration was also carried out each time. The percentage of nitrogen content was calculated from the volume of 0.02 N hydrochloric acid required during titration. The percentage of nitrogen was calculated by multiplying the nitrogen content by a factor 6.25 (A.O.A.C., 1990).

$$\text{Nitrogen (\%)} = \frac{(S-B) \times N \times 14.007}{\text{Weight of sample (gm)}} \times \frac{\text{Volume made}}{\text{Volume taken}} \times 100$$

Where,

S : ml of hydrochloric acid required for sample titration.

B : ml of hydrochloric acid required for blank titration

N : Normality of HCl (0.02)

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

5.4 Determination of Total Fat Content

The total fat content of the sample was estimated by Soxhlet method (A.O.A.C., 2005). The soxhlet flask of 250 ml was cleaned and dried in an oven. Record the weight of the empty flask. Add 5gms of the sample in a pre-weighed thimble and plugged with fat-free cotton. Then record the weight of the thimble with the sample and place the thimble in the siphon portion of the Soxhlet apparatus. The mixture of petroleum ether and diethyl ether was added in the round bottom flask of the soxhlet's apparatus and it was connected to siphon and condenser. The condenser was plugged with moistened cotton. It was refluxed for 5-7 times at 60°c. then the ether was distilled off and the flask was placed on a hot plate for 3 hours at 105°c for drying, and then cooled in a desiccator and weighed. The total fat content of the sample can be calculated by the formula

$$\text{Fat content (\%)} = \frac{W_2 - W_1}{X} \times 100$$

Where,

W_1 = weight of empty round bottom flask

W_2 = weight of round bottom flask after extraction

X = weight of the sample

5.5 Determination of Total Carbohydrate Content

The total carbohydrate content was determined by anthrone method (N.I.N.,1983).

Standard preparation:

A stock solution was prepared by dissolving 100 mg of glucose in 100 ml beaker. Take working solutions of 0,0.2,0.4,0.6,0.8 and 1.0 ml and make up the volume for 1 ml by adding distilled water.

Sample Preparation:

Weigh accurately 100 gms of sample into boiling tube and was hydrolyzed by keeping in the water bath for 3hrs with 5 ml of 2.5 ml of HCl and cooled to room temperature. And neutralize the extract with solid sodium carbonate until the effervesces ceases. Make up the volume to 100 ml in a volumetric flask and centrifuge. Collect the supernatant solution and take 0.5 ml and 1.0 ml aliquots for analysis into test tubes. Make up the volume to 1ml with distilled water.

Calibration of standard curve:

Add 4 ml of anthrone reagent to all the Standard and sample test tubes and heat in a boiling water bath for 8 minutes. Cool rapidly, a green to bluish-green color develops and read at 630nm. Plot the standard graph for different concentrations of the standard and derive the concentration of unknown sample by intercepting the graph.

$$\text{Amount of carbohydrates (mg \%)} = \frac{\text{mg. of glucose}}{\text{Volume of test sample}} \times 100$$

5.6 Determination of Total Sugar:

The total sugar content of the sample extracted in the aqueous solution (80% ethanol) was determined by the method of Nelson.

The sample was ground into powder and 1gm of a sample was extracted with 10 ml of 80% ethanol (boiling). The extraction was repeated 4 times by centrifugation at 10000 x g for 15 min. the ethanolic extraction was evaporated to about 100 ml with water. The aqueous extract was used for the determination of reducing sugars. Take 25 ml of the extract in 50 ml

volumetric flask to this add hydrochloric acid and ethanol in 1:1 ratio and placed in hot water bath for 30 min. then neutralize with sodium hydroxide and make up the volume to 50 ml. this solution is used for determination of total sugars.

To 1 ml of the sample extract add 1 ml of copper sulphate reagent, mix it thoroughly and heat for 20 mins in boiling hot water bath. Then cool the solution and add 1 ml of arsenomolibdate reagent. The mixture was diluted to 8 ml and optical density was measured at 520 nm. The total sugar content was calculated from a standard curve prepared by the same procedure by D-glucose at concentrations of 0, 10, 10, 30, 40 and 50 µg/ml.

5.7 Estimation of Crude Fiber

The crude fiber content of the sample was determined by the method of A.O.A.C (1990). Weigh accurately 2.0 grams of moisture and fat-free sample in 500 ml beaker. Then 2ooml of 0.225 N sulphuric acid is added into the mixture was allowed to boil for 30 mins keeping the volume constant by addition of water at frequent intervals, glass rod was used to stir the solution which helped for smooth boiling. The mixture was filtered through muslin cloth and residue was made acid free by washing the mixture with hot water. then transfer it to a beaker and add 200ml of 0.313 N sodium hydroxide and boiled for 10 min keeping the volume constant with distilled water. Then filter the mixture using a muslin cloth and make it alcohol and alkali-free by washing it with hot water. Then the residue was transferred to crucible and oven dried overnight at 80°c and weighed accurately (W1). The crucible was heated in a muffle furnace at 600°c for 2-3 hours and then cool it in a desiccator and weighed again accurately (W2). The difference between the two weights was considered as the weight of crude fiber in the moisture and fat-free sample. The crude fiber content of the given sample is calculated by the formula.

$$\text{Crude fibre content (g/100g)} = \frac{(W_1 - W_2)}{\text{Weight of sample}} \times 100$$

5.8 Estimation of Vitamin – C

Vitamin c content of the sample was estimated by A.O.A.C method (1984).

Standardization of dye :

Take 5ml of the standard ascorbic acid solution and add 5 ml of metaphosphoric acid and mix well. fill the burette with the dye. Titrate with dye till the pin color solution persist for 15 sec. determine the dye factor using the formula

$$\text{Dye factor} = \frac{0.5}{\text{Titer value}}$$

Preparation of Sample:

Take 2-10 gms of the sample, blend with 3% metaphosphoric acid and make up the solution to 100 ml with metaphosphoric acid. Filter and centrifuge the sample.

Take an aliquot of 2- 10 ml of the metaphosphoric acid extract of the sample and titrate it with dye till the pink color persists for 15 secs. In the next determination add most of the dye required and then titrate accurately. The aliquot of the sample should be taken such that the titer value should not exceed 3 – 5 ml. the ascorbic acid content of the sample was calculated by given formula.

$$\text{Mg of ascorbic acid per 100gor ml} = \frac{\text{T.V x (Dye factor) x (volume made up) for estimation}}{\text{Aliquot of extract x wt. Or volume of sample taken for estimation}} \times 100$$

where,

T.V = Titer value

5.9 Determination of Energy Content

The energy content of the sample was computed by summing up the values obtained by multiplying the values with Atwater constants for carbohydrates with 4, crude fat with 9 and proteins with 4 (N.I.N., 1983).

5.10 Estimation of β - carotene content

β -carotene content of the developed products was estimated by the procedure given by Zakaria et al. (1979).

Weigh 1-2 gms of the Powdered sample. Add 10 ml of working alcoholic KOH solution; shake it in a water bath at 37°C for 20minutes or in a vortex mixer for 10minutes. Transfer the contents to separating funnel. Extract 3-5times with 50ml petroleum ether, remove lower alcohol layer and keep aside the upper solvent layer in a separate conical flask. Add the pooled petroleum ether back to the separating funnel and wash 3 times with distilled water. Disperse the petroleum ether into a conical flask and add about 10-15g of anhydrous sodium sulfate to remove any traces of moisture from the solvent.

Calibration of standard curve:

The small quantity of standard beta-carotene powder is dissolved in petroleum ether (60-80°C) to get around 1.00 A absorbance. This is the stock solution for which the concentration calculated based on the Molar Extinction Coefficient.

Working standard solution is taken in the volume of 0, 0.2, 0.4, 0.6, 0.8 and 1.0ml from the stock solutions and the volume is made up to 1ml by adding petroleum ether (60-80°C). The optical density readings are taken in the spectrophotometer at 450 nm. A standard graph is obtained with different concentrations of the standard and the concentration of unknown is intercepted from the graph. The β- carotene content in the sample can be found by the given formula.

$$\text{B- carotene (µg\%)} = \frac{\text{Concentration of the β- carotene in a sample}}{\text{Volume of test sample}} \times 100$$

5.11 Calcium

The calcium content of the sample was estimated by EDTA titration method.

0.5 g of a sample which was previously oven dried was taken in 250 ml conical flask and 10 ml of nitric acid was added to the conical flask and was placed overnight undisturbed. then add 5ml of H2O2 to the flak and was heated on a hot plate until the solution was decreased to 1-2 ml in the flask they were cooled to room temperature and was diluted by using distilled water by rinsing through the neck. contents were transferred to 100 ml volumetric flask and volume is made up and filtered. Aliquots of 0.5 ml were prepared and 5 drops of 4 N sodium hydroxide and 50 mg of ammonium purpurate as an indicator it was added. This solution mixture was titrated with EDTA and color change was noted as an endpoint from orange-red to lavender purple. The volume of 0.01 N EDTA solution was required to neutralize the sample was noted and given by the formula.

$$\text{Ca (me/lit)(a)} = \frac{\text{R x Normality of EDTA x 1000 x 5}}{\text{Aliquot (ml) taken}}$$

5.12 Estimation of iron bioavailability (in vitro)

The Iron was estimated in vitro by the procedure by Lock and Bender 1980.1g of a sample was taken and 50ml of 0.03 N HCl was added and incubated at 37°C in a shaker come water bath for 3 hours. This was done to make the conditions like as of the human stomach. Then filter the mixture through an ashless filter paper. (Wattman no 42) then the filtrate was oven Dried, digested in the mixture of nitric acid: Perchloric acid in 5:1 (V/V)ratio. And was processed for determination of iron content. The extractability was determined as given below:

$$\text{Extractability (\%)} = \frac{\text{HCl extractable mineral (mg)}}{\text{Total mineral (mg)}} \times 100$$

(HCl extractability is an index of bioavailabilty of iron)

5.13 Fat Absorption

All the products were analyzed for fat content by repeated extraction of fat for 6 h by petroleum ether in a Soxhlet distillation apparatus and were determined gravimetrically. The percent oil absorbed for all the samples was calculated (AOAC 1983).

5.14 Sensory Analysis

The sensory analysis was carried out as it was given in the paper of Leena Sebastian et al., 2005.

The set of prepared samples were subjected to sensory analysis using the sensory panel members. One set of the product was presented at one time to each panel members. The panel members were the students and faculty members of the university who were under the department of food science and technology. The panel members were selected in such a way that person should be familiar with sensory analysis techniques. The products where coded and there were presented in the random order to the panel members along with the sensory ballot and they were asked to rate the sensory attributes of the product which included color, flavor, texture, appearance and overall acceptability on a 10- points hedonic scale. The rating on the scale was as follows 1-2 for poor, 3-4 for fair, 5-6 for good, 7-8 for very good and 9-10 for excellent. The resulted data were collected and analyzed for mean, standard deviations and significant differences in sensory ratings in comparison with control.

5.15 Storage Study

The prepared products were stored at low temperature (refrigeratorat8C) in sealed polyethylene containers, and at room temperature in sealed polyethylene containers and in PET (polyethylene terephthalate) bottles. These were analyzed for free fatty acid (FFA) content at 0, 7, 14, 21 and 28 days (AACC 2000).

EXPECTED OUT COMES CHAPTER 5

The use of the combination of flours and oilseeds in preparation of multi-nutrient chakli was to enhance the nutritional quality of the traditionally made chakli. To study the preparation of multi-nutrient chakli using two different methods by using deep fat oil frying and by the baking method. And also, to improve the shelf life of the product. This chakli will serve as a traditional food which can be incorporated into the diets of the people suffering from obesity and the people suffering from gluten allergies.

The present study on 'PREPARATION OF TRADITIONAL MULTI GRAIN CHAKLI' was carried out in the Department of Food Science and Technology, Lovely Professional University, Punjab, India. The results obtained during the investigation are discussed here:

7.1 PROXIMATE ANALYSIS OF RAW MATERIALS

The table 7.1 depeicts the chemical composition of the various ingredients (Raw materials) used in the preparation of the snack which include the composition of Sorghum, Pearl millet, Finger millet, Oats, Rice, and Sesame seeds.

The composition of Sorghum flour was estimated to be moisture content of 10.13±0.30 *Samuel Ayofemi Olalekan Adeyeye (2016) fat* 3.16%, protein 10.43, ash 1.6±0.1, crue fiber 2.43±0.15, carbohydrates 70.2±0.37, *R.V. Jaybhaye1et al., (2014),* reported similar composition of Sorghum flour.

The composition of Pearl millet was estimated to be moisture content 12.3±0.02, fat 4.82±0.03, ash 2.22±0.03, protein 11.8±0.04, crude fiber 2.33±0.15, carbohydrates 67.01±0.03 *R.V. Jaybhaye1et al., (2014),* cited similar composition of Pearl millets.

The composition of Finger millet flour was found to be moisture content 13.1±0.20, ash 2.73±0.15, protein 7.3±0.1, fat 1.3±0.01,crude fiber 2.73±0.15 and carbohydrates 71.93±0.15 *mushtari begum j et al., (2017)* reported similar results of Finger millet.

The composition of Rice flour was eatimated to be moisture 10.2±0.1, fat 0.46±0.05, proteins 6.84±0.05, ash 1.33±0.05, crude fiber 0.23±0.05 and carbohydrates 66.36±0.15 *mushtari begum j et al., (2017)* observed similar results in rice.

The composition of sesame seeds was found to be moisture 4.76±0.05, fat 51.93±0.15, protein 19.86±0.20, ash 5.3±0.1, crude fiber 10.96±0.02 and carbohydrates 18.5±0.1 *Jaya Singh et al., (2016*) cited similar results of sesame seeds.

The composition of Oats was found to be having moisture 13.02±0.01, fat 6.91±0.08, proteins 16.94±0.06, ash 2.0±0.005, crude fibres 9.1±0.15, and carbohydrates 66.36±0.15 *Y. LIU et al.,(2000), Caike Zhang et al., (2014) and Maboodurrahman (2015)*cited similar results of composition of oats.

Ingredients	Moisture content (%)	Fat (%)	Proteins (%)	Ash (%)	Crude fiber (g/100g)	Carbohydrates (%)
Sorghum	10.13±0.30	3.16±0.85	10.43±0.47	1.6±0.1	2.43±0.15	70.2±0.37
Pearl millet	12.3±0.02	4.82±0.03	11.8±0.04	2.22±0.03	2.33±0.15	67.01±0.03
Finger millet	13.1±0.20	1.3±0.01	7.3±0.1	2.73±0.15	3.6±0.1	71.93±0.15
Oats	13.02±0.01	6.91±0.08	16.94±0.06	2.0±0.005	9.1±0.15	66.36±0.15
Rice	10.2±0.1	0.46±0.05	6.84±0.05	1.33±0.05	0.23±0.05	78.21±0.07
Sesame	4.76±0.05	51.93±0.15	19.86±0.20	5.3±0.1	10.96±0.02	18.5±0.1

Table 7.1 Chemical Composition Of Raw Materials (n=3)

1. (Manach *et al.*, 2005; Scalbert *et al.*, 2005; Chandrasekara and Shahidi, 2012). The important nutrients present in millets include resistant starch, oligosaccharides, lipids, antioxidants such as phenolic acids, avenanthramides, flavonoids, lignans and phytosterols which are believed to be responsible for many health benefits (Miller, 2001; Edge *et al.*, 2005).
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