DEVELOPMENT AND CHARACTERIZATION OF VALUE ADDED PRODUCTS FROM LOCALLY AVAILABLE MILLETS

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By

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ABSTRACT

The objective of the present study was the development of fiber rich and gluten free cookies by employing underutilized cereal i.e., pearl millet (*pennisetum glaucum*). Pearl millet is a rich source of dietary fiber and minerals but has a disadvantage of having anti nutritional factors. Therefore, pearl millet was soaked overnight and germinated for 72h at room temperature to reduce the anti-nutritional factors such as phytic and tannic acid; and to improve the nutritional value of the final product. To provide the bulk and strength, potato starch was used as an ingredient. Six different combinations viz. non-germinated pearl millet flour (NGPMF): potato starch (PS) (70:30; 60:40; 50:50), germinated pearl millet flour (NGPMF): potato starch (PS) (70:30; 60:40; 50:50) along with control (100% wheat flour) were prepared for cookies formulation. The prepared cookies were organoleptically analyzed on the basis of 9 point hedonic scale. Data suggested that 50:50 combination of cookies irrespective of the state of pearl millet flour was optimum and comparable to control. Therefore, this combination was selected for further physico-chemical analyses. Results revealed that NGPMF contained 11.71±0.28% moisture content, 2.54±0.19% ash content, 4.96±0.57% fat, 11.62±0.01% protein, 2.2±0.05% fiber, 2.30±0.34g/100g total phenols and 8.8±0.1mg/100g iron content. Similarly, GPMF contained 13.28±0.24% moisture content, 1.66±0.33% ash content, 4.45±0.50% fat, 15.5±0.006% protein, 1.48±0.07% fiber, 1.80±0.33g/100g total phenols and 7.8±0.2 mg/100g iron content. Gluten free cookies were prepared by using NGPMF as well as GPMF. Data suggested that moisture content, carbohydrates, fats, proteins, ash, fiber, total phenols and iron ranged from 6.71-7.03%, 45.40-49.6%, 18.6-21.0%, 10.28-11.70%, 1.55-2.10%, 1.60-2.13%, 0.59-1.20 g/100g , 6.50-7.10 mg/100g in different type of cookies. Germination of pearl millets improved the proteins and reduced the level of phenols in cookies. Sensory data showed that cookies prepared from GPMF had better sensory attributes and overall acceptability as compared to cookies developed using NGPMF. Although control cookies showed significantly higher ($p<0.05$) sensory scores than that of GPMF cookies, but the later one were in acceptable range. Overall, it can be concluded that GPMF and potato starch in 50:50 ratio could be successfully used for the development of gluten free and fiber rich cookies.

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I am grateful for having the opportunity to pursue a graduate degree.

Date **Vimala K.S**.

DECLARATION STATEMENT

I hereby declare that the work presented in Dissertation I entitled "Development and characterization of value added products from locally available millet**"** is my own and original. The work has been carried out by me at School of Biotechnology & Biosciences, Lovely Professional University, Phagwara, Punjab, India under the guidance of **Dr. Ankit Goyal,** Assistant Professor (Food Technology) of School of Biotechnology and Biosciences, Lovely Professional University, Phagwara, Punjab, India, for the award of the degree Master of Technology in Biotechnology.

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

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CERTIFICATE

This is to certify that the thesis entitled **"Development and characterization of value added products from locally available millets"** is a bonafide work carried out by **Ms. Vimala K.S (Regd. No. 11300925**) M.Sc. Food Technology student of Lovely Professional University under my guidance towards the partial fulfillment of the degree in M.Sc. Food Technology during the academic session 2014 - 2015. The work described is original and has not been submitted for any degree to this or any other university.

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AACC – American Association of Cereal Chemists

AOAC – Association of Analytical Chemists

ANOVA – Analysis Of Variance

FAO – Food Agriculture Organisation

G – Gram

GPMF – Germinated Pearl Millet Flour

GPMC – Germinated Pearl Millet Cookies

l – Liter

NGPMF – Non-Germinated Pearl Millet Flour

NGPMC – Non-Germinated Pearl Millet Cookies

OD – Optical Density

RDA – Recommended Dietary Allowance

mg – Milligram

h – Hours

NRAA – National Rainfed Area Authority

INTRODUCTION

Millets are heterogeneous group of small seeded grasses, which are widely grown in arid and semi-arid regions of the world. Nowadays underutilized crop (Millets) acquire the current scenario mostly in developing countries owing to their higher nutritionary worth (macro and micronutrients), highest production and simple harvest home on all climacteric conditions like marginal, hot and dry conditions wherever some cereal crops do not seem to be capable to grow.

In ancient time millets are known as poor man food as well as food for animals, however contemporary utilization of those millet varieties in terms of product for human consumption in market level. Among all millet crop variety pearl millet (Pennesitum glaucoma) may be a most mounting crop in Asian nation. As a tropical food cereal, it stands fourth within the world.

In India among millet variety pearl millet stands first. It is employed in giant industrial scale because of their presence of all required nutrients. There are varied food product like baby foods, snack foods, baked product, extruded product like sev and sweet pasta, flakes and pops, dietary food and recently lassi made up of pearl millet flour. Bioavailability of the pearl millet is low because of presence of inherent anti-nutritional factors. Treatment process like milling, malting, blanching, acid treatment, dry heat treatment and parboiling (NRAA, 2012). In Niger cultivated land are more than 65% (7.5 million ha-1) of pearl millet crop that is one in all the foremost vital crop (Mariac *et al.,* 2006). The world total production of millet seeds was estimated as 12660000 MT IN 2011, 704,239 tonnes in 2012 with India being the top producer (273,000 tonnes) followed by Niger (106,427 tonnes) and Nigeria (60,800 tonnes) (FAO, 2014).

The nutrient composition of pearl millet per 100g edible portion it contains protein 11.8g, fat 4.8g, Ash 2.2g, Crude fiber 2.3g, Carbohydrate 67.0g, Energy 363, Calcium 42g, iron 11.0mg, thiamin 0.38mg, riboflavin 0.21, and niacin 2.8mg (Hulse *et al.,* 1980). Among all cereals, millet has its own uniqueness intended for the richness of calcium, polyphenol, dietary fiber content and protein stated by (Devi *et al.,* 2011)

Even though millets are higher in micronutrient content compared to different cereals, it lacks in bioavailability and digestibility of protein, carbohydrate and minerals, particularly iron and zinc in cereal based mostly products because of the presence of anti-nutritional properties like Phytate, such kind of Phenolic and dietary fiber content. (Camara and Amaro, 2003).

To reduce Phytic acid content various experiment has been carried out such as germination / Sprouting, roasting and fermentation techniques. Presence of pigments on pearl millet within the natural covering and reproductive structure of the pearl millet where it affects the merchandise color and consumer satisfactoriness. The impact of depigmentation on sensory and quality of nutrition in biscuits were conducted by found that the sensory attributes specifically the color of pearl millet was fascinating and in vitro the digestibleness of protein as well as starch, however as a result of depigmentation the amount of protein, starch, total dietary fiber was diminished at intervals the end result of biscuits. (Rathi *et al.*, 2003)

The consumption of millets may be in numerous manner of way of preparation victimization flour and malt of the grains. From millet there are lot of foods prepared include cooked products, porridges, fermented based breads, boiled rice products, alcoholic and non- alcoholic beverages and snacks.(Murty & Kumar, 1995). Millet is gluten-free also; therefore an excellent option for people suffering from celiac diseases often initiated by the gluten content of wheat. According to (Makharia *et al.*, 2011), 1 out of every 96 person in north Indian community is suffering from celiac disease. Celiac disease is an allergy to gluten protein. Moreover, Millet retains its alkaline property after cooking which is good for wheat allergy people (Vanisha *et al.*, 2011).

In this dissertation work cookies were prepared by exploitation pearl millet flour together with starch potato that is additionally gluten free still as iron rich and reduced anti- nutritional factors. With this background, the treatise project was designed to utilize locally available millet grains in development of value added products and can be accomplished with following objectives.

Pearl millet *(Pennisetum glaucum)* or bajra is one amongst the vital minor cereal crop on sixth place. In ancient days the pearl millet is one amongst the staple food for poor population and low economic standing population and still in developing countries this is often a significant food. Sometimes it is used as an animal feed. However, these days utilization of pearl millet variety came in to the image because of their high nutritional value compared to different cereals. Utilization of pearl millets is proscribed because of presence of anti-nutritional factors like phytic acid, tannins and oxalates. However they will be reduced by completely different process ways like soaking, blanching, germination, roasting, and fermentation.

The present work is projected to utilize the underutilized crop in development of healthy bakery product which can be cost effective and beneficial for person laid low with iron deficiency and celiac disease alongwith traditional population.

3.1 Millet

Millets are heterogeneous group of small seeded grasses, which are widely grown in arid and semi-arid regions of the world. This crop encompasses a excellent immune to drought conditions and stress tolerant to agro – weather conditions (Ushakumari, 2009). The use of the millets is extremely confined to ancient consumers and low economic status population. Investigation is applied to finish the poverty and hunger through production, processing methods and utilization of millets. **Jaybhaye *et al.*, (2014)** developed completely different variety of food products owing to health beneficial consciousness of consumer. And conjointly they reviewed about different way of traditional processing and how to mechanizing those processes as per the convenience where it includes ready to eat (RTE) food product with varied characteristics.

Attempts were created to extend the assembly of millets and financial gain of farmers in Tamilnadu victimization new ways of farming. By the new technology increased the proportion level of every minor crop like finger millet (82%), little millet(95%), kodo millet (83%), Italian millet (43%), and barnyard millet (82%) . Therefore, cultivation of little millet is simply allotted by low socio- economic

standing farmers with low input and might get lot of yields. Millet production is additionally thanks to high nutritionary price and health edges. It is a special feature of gluten free that is useful for gluten intolerant folk. It is additionally useful for people who do not have a physical activity and awareness ought to be created by inclusion of millets in our daily meals for healthily living to beat the inactive mode of lifestyle (Michaelraj & Shanmugam, 2013).

Millets are higher option for security of the food. The Phenolic content of millet is extremely high that exhibit the antioxidant (inhibitor) property and high bio-accessibility. These phenolic were helpful in interference and cure of cancer by scavenging free radicals and polygenic disorder attributable to lower glycemic index (Shahidi & Chandrasekara, 2013).

3.2. Pearl millet

The Potential functional implications of pearl millet in health and disease. Pearl millet which underutilized food known as poor people food and also staple food for many populations. Being high nutritional value as well as non-nutrition (phenolic content) it prevent and reduce most health disease by consumption. Because it contain high level of energy, high fiber content (1.2g/100g), good amylase activity (8-15 times greater) than other cereal and less glycemic index (55), protein (8-19%) and it has gluten free component. Due to gluten free part it is steered for celiac disorder treatment, constipation patients and non- communicable diseases people. So the millet consumption have a potential functional implication in health and disease reviewed by Nambiar *et al.,* (2011)

Influence of depigmentation of pearl millet on sensory attributes, nutrient composition, in vitro macromolecule and starch edibleness of biscuits. Pearl millet primarily based biscuits typically offers non satisfactoriness for consumer attributable to their gray color that is non- appealing. To beat this sensory issue such treatment has been conducted to enhance the color and conjointly biological process composition of biscuits. Three sorts of biscuits were ready, during this refined flour is mangement, unprocessed flour, and de-pigmented flour. Once production of product the sensory attributes are sensible and acceptable in de-pigmented flour created biscuits and conjointly the biological process like macromolecule, ash, and total dietary fiber

higher relatively than control biscuits. In order that they all over that there is sensible sensory, biological process price by this depigmentation treatment that is most acceptable to consumer **Rathi *et al.*, (2004).**

There is a comparative Performance of Pearl millet-and Sorghum primarily based Diets versus Wheat-and Rice-based Diets for Trace Metal Bioavailability. During this they ascertained bioavailabilty of iron and zinc improves by the substitution of Pearl millet performance excluding the sorghum. Average absorption for three periods of five days was higher for Pearl millet and wheat relatively than different like sorghum and rice. Therefore, compare to the wheat and rice pearl millet and sorgjum good source of energy. Pearl millet having upper most level of trace metal bioavailability than the sorghum study which has been conducted by **Agte, *et al.*, (1999)**

3.3. Nutritional value

The study conducted on the structure, physicochemical properties, and uses of millet starch. It is chiefly centered on to summarize the isolation, chemical science, structure, chemical properties, protein condition, enzyme modification and starch of the millet was used. As a result the measurement of millet starch noted wherever the number reaches 70% of the seed, this solely verify the millet product quality. Owing to the prevailing data concerning millet starch there is broadened diversity in changed and native starches wherever it is more utilized. By conducting various process ways they achieved reduction in protein condition to alpha amylases. In this study they concluded that analysis is required more for the starch variety which has to utilize within the improvement and quality **Zhu, F. (2014)**

Millet is the energy source because it provides good protein, mineral, fatty acid, vitamins, dietary fibre and polyphenols. It gives so many health benefits like it serves as a characters as prebiotic and probiotic. Another important role is antioxidant acitivity. Due to good and high nutritional value and functional properties the cultivation of millet got increased as well as the value added product comes in to the market circle. There is successful outcome attributes which can expand the spectrum for millet grain applications. Even though, they mentioned that future study for

consumption of millet and industrial revolution should be taken (**Issoufou *et al.*, 2013).**

To increase the higher nutritive value on millet there is another method which is fortification of sorghum and pearl millet flour along with iron had been done. It is the feasibility nature incorporation too. Investigation about iron fortification (6mg/100g) and in vitro folic acid and EDTA and mineral content. At this experiment there is an increase in bioaccessible iron content in pearl millet as well as sorghum flours. And there was a further inclusion of EDTA will make more bioaccesssibility of iron content in both the flour. As per the storage period for fortified flour product had lower bioaccessible when compared to freshly fortified flour sample, but the products which is prepared from unfortified flours is less. So these kind of fortified flours to be used as a programmes of supplementary feeding which can be useful for deficiency in iron **Tripathi & Platel (2013)**

3.4. Anti-nutritional value

To reduce the anti nutritional factor which present in the finger and pearl millet variety there was a domestic processing done on the polyphenol content and their bioaccessibility. Examination done by various processing methods like sprouting method, boiling method as open pan and pressure cooking. Then as a result they have noticed that by there is reduction of total polyphenol content by sprouting (by 50%) and by open pan boiling (by 12-19%). And there is increased bioaccessibility of polyphenol content by giving the processing method of sprouting and roasting **Hithamani & Srinivasan, (2014)**

Another effective method incorporated to eliminate the anti-nutritional factor in pearl millet. Treatments are germination, roasting and fermentation on the proximate composition, and functional properties of pearl millet. And he evaluated the standard methods for proximate, minerals, antinutritional factors and functional properties. By using RVA method elastic property was determined. As a result there is increased level of crude protein and carbohydrate level of germination methods. And also increase in the water and oil absorption capacity,gelation concentration and bulk density of the flours. In contrast in fermentation process the crude protein is increased and the level of carbohydrate is decreased. They concluded that as a

desirable quality this kind of food system is important and which will satisfy the consumer quality and safety **Sade. F. O. (2009)**

Another effective germination and natural fermentation methods were conducted on the instant fura. The germination method done for 12hr and 48hr. They have separated as per the convenience like germinated and non-germinated flour as two portions, in this one should be for fermented fura and another for production of germinated fura. They have followed standard assay procedures for the sample nutrient composition and phytic acid evaluation. They concluded that when compared to the non -germinated fura the sensory is good in germinated fura . And also there is significant decrease in phytic acid in germinated fura and increased protein, ash, crude fibre, phosphorus, calcium and iron levels in fura **Inyang *et al.*, (2008)**

There is a extractability of phytic acid and hydrochloric acid in pearl millet as affected by timing and cultivar of germination. They have choosen Ten pearl millet cultivars and they germinated for 96hr. Then it was dried and milled. They examined during germination with 24hrs intervals the HCL extractability from the malt flour.They concluded that there is significant ($P < 0.05$) reduction in the part of iron, calcium, phosphorus, copper and manganese as well as phytic acid content **Badau, *et al.*, (2005)**

Same HCL extractability method has been conducted in pearl millet sprouts. To identify that after sprouting whether there will be reduction of phytic acid. They notified that there is significant increase of phosphorus, calcium, iron and zinc in HCL extractability. Absorption done by spectrophotometry, calcium is estimated by titration method and Colorimeteric method for hytic acid determination. They concluded that this is beneficial method in phytic acid reduction Improvement of protein digestibility and HCL extractability of phosphorus, calcium, zinc and iron **Kumar, (1993)**

3.5. Cookies

Dhankhar (2013), developed the gluten free cookies from coconut powder. He was subjected the raw material for various proximate analysis and prepared cookies were analyzed with various parameter such as, sensory. Nutritional, physical, storage method, safety of microbes and indices of texture. In this study he had used

only coconut powder instead of using wheat. Apart from spread ratio value in every parameter this coconut gluten free cookies having good acceptability from consumer. Especially for celiac patients which having a good nutritional values.

Sakac *et al.*, (2014) developed gluten free cookies from rice and buckwheat and undergone the analysis of antioxidant, sensory, mineral content on this prepared cookies. They prepared with the combination of light buck wheat flour with the substitution of rice flour 10%, 20% and 30%. Out of this combinations 20% is acceptable in the analysis of sensory and consumer acceptability. And the analysis of antioxidant activity was food in 20%, 30% compared to the other cookies. Therefore, the combination of buckwheat flour and rice flour made cookies having higher phenolic and rutin content.

Surekha *et al.*, (2013), developed value added cookies from plain, pulse and vegetable by using sago flour, green gram dhal with soya bean flour, carrot grated respectively to barnyard millet flour in different ratios. The nutritional value and the storage quality analysed according to the desirable cookies. At last pulse and vegetable cookies were acceptable by the consumer and also noticed that there was a significant increase in micro and macro nutrients in that cookies with 40-60 days storage shelf life.

Chappalwar *et al.*, (2013) revealed that the cookies were made from oats and finger millet based composite flour oats and finger millet flour was mixed with wheat flour at ratios 10:10:80, 20:20:60, 30:30:40 and 40:40:20 respectively. Chemical composition of cookies showed that oat and finger millet flour addition improved the dietary fiber ranging from 1.45% to 3.05%, protein 8.30% to 10.69% and crude fat between 21.32% and 23.37%. The proximate composition analysed that control cookies having higher moisture content than that of oats and finger millet flour combinations. Higher level of ash, crude fat, crude protein and crude fiber noticed in oats and finger millet flour cookies with good consumer acceptability.

Falola *et al.*, (2011) examined the quality of cookies made from composite flour of cassava and cucurbit flour. The substitution of cassava flour starting from 5 to 30%. There was a increase in protein and decrease in carbohydrate content noticed. There was a increase in ash content percentage with increase in the proportion of

cucurbit mixta flour. There was a potential ability of nutritional component for malnutrition children and adult due to protein deficiency.

The pearl millet is an underutilized minor crop especially used as animal feed. Because of high nutritional value, its use for human consumption is also increasing. The nutritional value of pearl millet especially micronutrients is more than the cereal grains. Pearl millet is incorporated in different bakery products in combination with wheat flour. In bakery products, cookies are most commonly desirable for consumer due to modernization and upgradation in food consumption, nowadays.

Therefore the present dissertation work is designed to utilize pearl millet in development of value added product like cookies and to analyze the developed product. Particularly, the investigation focused on composition, processing methods, anti-nutritional factors, physicochemical and functional property of pearl millet flours and sensory quality of pearl millet based value added products.

The scope of the study as follows:

a) Low economic cost
b) Availability of the grain in all climatic conditions
c) Formulation even in small scale industries
d) Health benefits for celiac disease who are allergic to gluten and iron deficiency persons and also normal population.

OBJECTIVES

1. Physico-Chemical analysis of Pearl millet and optimization to reduce the anti-nutritional factor.
2. Processing parameters for the formulation of millet based gluten free cookies.
3. Evaluation of developed product for its physico-chemical, Sensory and Nutritional Characteristics.

This chapter deals with the experimental details and methodology employed in the completion of present study entitled "Development and characterization of value added products from locally available millet". It also consists of details of analytical procedures such as physico-chemical, sensory and statistical analysis used for characterization of raw materials, processed material and final product.

6.1 Raw ingredients

6.1.1 Pearl millet

Good quality pearl millet grains were procured from a reputed merchant located in local market of Jalandhar (Punjab). The grains used were free from foreign substances like soil particles, stones, weed grains, pest infected seeds and insects.

6.2. Processing methods

6.2.1. Germination:

The grains were washed with 1.5% formaldehyde solution to avoid fungal contamination, then were washed with sterile distilled water thrice to ensure no residual formaldehyde; tested using ferric chloride method described by VICH Steering Committee (2002). The grains (1Kg) were then soaked in potable water (4L) for 15h and were then kept for germination wrapped in wet muslin cloth. The germination wrapped in wet muslin cloth. The germination time was standardized by preliminary trials to 72h. Sample grains were taken at 12 h intervals and assayed for amylase activity as described by Chrispeels and Varner (1967). The maximum amylase acitivity was obtained at 72h.

6.3. Analysis Methods

The ingredients used in the development of processed pearl millet based baked food were analyzed for various physico-chemical, and nutritional parameters using the following methods.

Table 1 : Ingredients For Non- germinated Cookies:

Combinations	Wheat Flour (%)	Non germinated Pearl Millets Flour (%)	Potato starch (%)
Control	100%	-	-
T1	-	50%	50%
T2	-	60%	40%
T3	-	70%	30%

Table 2: Ingredients For germinated Cookies:

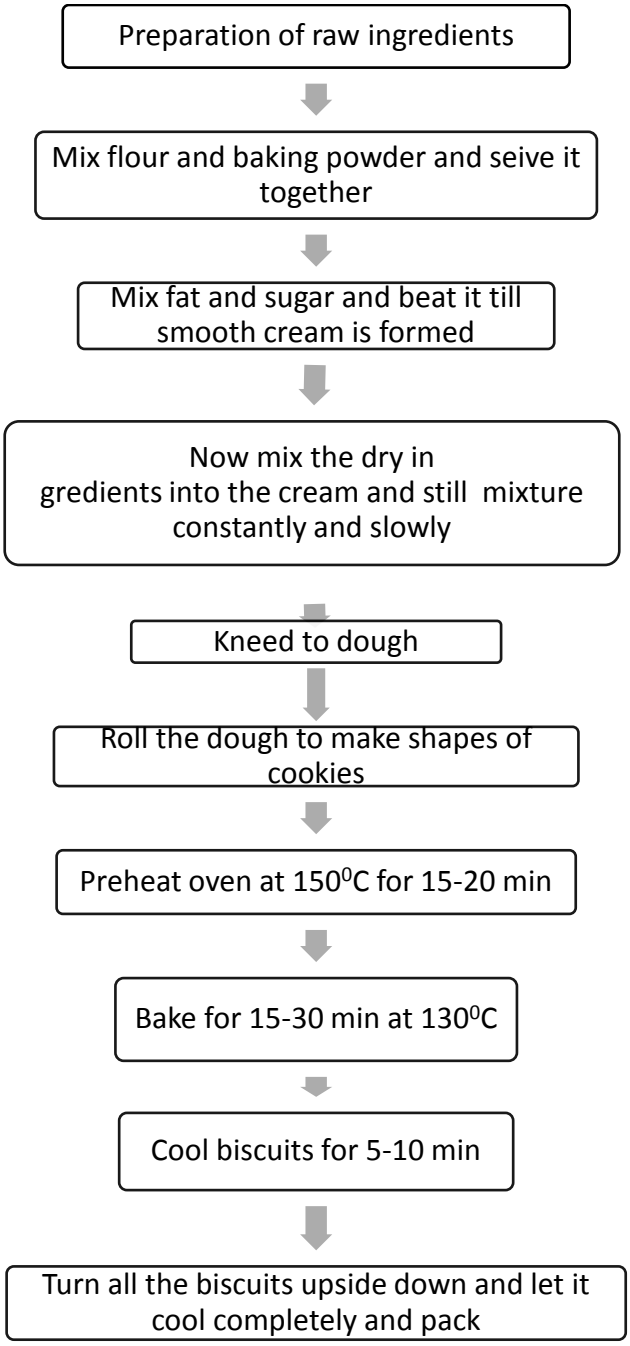
Combinations	Wheat Flour (%)	Germinated Pearl Millets Flour (%)	Potato starch (%)
Control	100%	-	-
T4	-	50%	50%
T5	-	60%	40%
T6	-	70%	30%

*T: Treatment

6.5. Chemical Analysis

6.5.1. Moisture Content (AOAC, 2000)

Moisture content was determined by the oven method. Five gram of sample was weighed into a petri plate and was placed into hot air oven at 105^0C for $1^{1/2}$ hour. After drying, the sample was taken out and immediately placed in a dessicator for



6.4. Flow diagram for the preparation of cookies

15-20 min and the final readings were observed on a weighing balance. Moisture content was calculated using the formula:

$$Moisture\ (\%) = \frac{Initial\ Wt - final\ wt}{wt\ of\ sample} \times 100$$

6.5.2. Total carbohydrate (Ranganna, 1986)

Total carbohydrates were calculated by the following formula:

Total carbohydrate % = 100 - (Moisture + Crude Ash + Crude Protein + Crude Fat + Crude Fibre)

6.5.3. Crude Fat (Ranganna, 2004)

Crude Fat was determined by soxhlet method. Five gram of sample was weighed and placed in an oven for one hour. Dried sample after moisture determination was then transferred to thimble and then the top of the thimble was plugged with cotton. This thimble is then dropped into the fat extraction soxhlet apparatus tube attached to soxhlet flask. Petroleum ether (about 75ml or more) was then poured through the sample in the tube into flask. Then condenser was attached to the fat extraction tube. Extraction was carried out for 6-8 hours or longer. At the end of extraction, thimble was removed from the apparatus and the flask was heated from some time so that ether present in extracted fat gets evaporated. It was then cooled for some time and then the fat containing flask was weighed. Crude fat can be calculated using formula.

$$\%\ Crude\ Fat = \frac{Final\ weight\ (gm) - \ Initial\ Weight\ (gm)}{Sample\ Weight\ (gm)} \times 100$$

6.5.4. Protein (Ranganna, 2004)

Protein content was determined by Lowry's method.

Different dilutions of BSA solutions were prepared by mixing stock BSA solution (50 mg/ 50 ml) and water in a standard flask. Extraction of sample was carried out with buffers used for enzyme assay. 0.5 gm os sample was weighed and ground in a pestle mortar with 5 ml of buffer. The mixture was centrifuged and supernatant was collected. 0.2, 0.4, 0.6, 0.8 and 1 ml of working standard was taken into series of test tubes. 0.1 ml of sample was taken in other test tube. 5 ml of alkaline copper solution was added in each test tubes including blank (1 ml distilled water). Mixture were mixed properly and were allowed go stand for 10 minutes. 0.5 ml of Folin- Ciocalteau reagent was added to each test tubes and kept in dark for 30 minutes. Readings were taken at 660 nm. Standard graph was plotted and amount of protein was calculated as mg/g or 100 g of sample.

6.5.5. Ash Content (Anon., 1990)

Five gram of sample was weighed in a silica crucible and charred to remove the inorganic matter. The process was continued till no more smoke emitted. The crucible with charred sample was ignited to ash in a muffle furnace at 550^0C for 6 hours. The crucibles were allowed to cool in desiccators and weighed. Ash content was calculated employing the formula:

$$\% \, Ash \, Content = \frac{Final \, Weight \, (gm) - \, Initial \, Weight \, (gm)}{Weight \, of \, sample \, (gm)} \times 100$$

6.5.6. Crude Fibre (AOAC, 2000)

Two gram of dry used residue from crude fat determination was taken in triplicate and digested with 200 ml of 1.25% H_2SO_4 by gentle boiling for 30 min. After 30 min, the flask was removed and contents were filtered through muslin cloth under succession. The residue free acid was washed using hot boiled water and then transferred to the beaker for alkali digestion by treating with 1.25% NaOH (200 ml) for 30 min. After 30 min of boiling, the flask was removed and immediately the contents were filtered through filtering cloth in a fluted funnel. Residue free of alkali was again washed by using hot distilled water. The residue was dried in an oven for 4 hrs. Cooled in a dessicator and weighed. The loss in weight after ignition represents the crude fibers content in the sample (AOAC, 1998).

$$\% \, Crude \, Fibre = \frac{Loss \, in \, weight \, noted}{weight \, of \, sample \, taken} \times 100$$

6.5.7. Tannin acid: (Ranganna, 2010)

Reagents:

Folin – denis reagent: To 750ml of water, add 100g of sodium tungstate, 20g of phosphomolybdic acid and 50ml of 85% phosphoric acid. Reflux the mixture for 2 hour, cool to 25^oc and dilute to 1000ml with water.

Saturated sodium carobonate solution: To 100ml of water, add 35g of anhydrous sodium carbonate dissolve at 70-80^o C and cool overnight. Decant the clear liquid before use.

Tannic acid standard solution: dissolve 100mg of tannic acid in 1 litre of water. Prepare fresh solution for each determination (1ml=0.2mg of tannic acid)

Preparation of standard curve:

Pipette 0 to 10ml aliquots of the standard tannic acid solution in to 100ml volumetric flasks containing 75ml of water. Add 5ml folin-denis reagent and 10ml $NaCO_3$ Folin-Denis reagent and 10ml Na_2CO_3 solution into each of the volumetric flask and makeup to 100ml with water. Mix well and measure the colour after 30 mins at 760nm against experimental blank adjusted to 0 absorbance.

Preparation of sample:

If solid, boil 5g of sample for 30mins with 400ml of water, cool, transfer to a 500ml volumentric flask and dilute to mark shake well and filter

Determination:

Use an aliquots of the filtrate containing not more than 0.1mg of tannic acid, proceed as in standard and obtain mg tannic acid from the standard curve, sample treated as above may also be compared in nessler tubes against freshly prepared tannic acid standards treated in the same manner.

Calculation:

$$\text{Tannin as tannic acid} = \frac{\text{Mg of tannic acid x dilution } 100}{\left(\begin{matrix}ml\ of\ sample\ taken\ for \\ color\ measurement\end{matrix}\right) X\ (weight\ of\ sample\ taken)\ X(100)}$$

6.5.8. Iron Content (Ranganna) (Wong, 1928)

Reagents:

1. Conc H_2SO_4 (iron free)
2. Saturated potassium persulphate solution : Shake 7 to 8 g of reagent grade iron free potassium persulphate with 100ml of water in a glass stoppered bottle. The undissolved excess settles to the bottom and compensates for loss by decomposition. Shake briefly using. Keep the reagent in the refrigerator.

3. 3N Potassium thiocyanate solution: Dissolve 146g of reagent grade potassium thiocyanate in water and dilute to 500ml. Filter if turbid. Add 20ml of pure acetone to improve the keeping quality.

Standard iron solution: Dissolve 0.702g of reagent grade crystalline ferrous ammonium sulphate in 100ml of water. Add 5ml of conc H_2SO_4, warm slightly, abd add conc potassium permanganate solution drop by drop until one drop produces a permanent colour. Transfer to a one-litre volumetric flask, rinse with water and make up to volume. This solution contains 0.1mg of ferric iron per ml and is stable indefinitely.

Procedure:

Use the ash solution of the sample prepared by dry ashing for colour development.

Colour development

Into three separate stoppered measuring cylinders, pipette the solutions

Calculation:

$$\text{Iron mg/100g} = \frac{\text{OD of sample x 0.1 x Total volume of ash solution x 100}}{\text{OD of standard x 5 x Weight of sample taken for Ashing}}$$

7.1 MOISTURE CONTENT

Moisture content and thus, water activity plays a pivotal role in determining texture and shelf life of the bakery products during the storage. If moisture content is more than the critical range, it can cause spoilage due to the microbial growth and can affect the crispiness, mouthfeel as well as other textural characteristics. On the other hand, if moisture content is below the critical range, it negatively affects the consumer acceptability by giving a hard texture. In general, 12-15% moisture content has been suggested by several workers for long term storage of cereal flours.

In the present investigation, moisture content of wheat flour (control), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) is shown in Fig. 1, which indicates that moisture content ranges from 11.38-13.55%. It can be observed from the data that there was a significant difference ($p<0.05$) among the moisture content of control, NGPMF and GPMF. However, in all the flours, moisture content remained well in the permissible range.

Similarly, the moisture content of developed cookies is given in Fig. 2. It is clear from the values that moisture content in the cookies ranged from 6.69.-7.05%. Data revealed that again, there was a significant difference ($p<0.05$) among the moisture content of cookies developed from control, NGPMF and GPMF samples, which could be attributed to the difference of cereal nature as well as minor processing operations.

It can also be suggested from the data that gluten free cookies prepared from germinated pearl millet flour contained significantly ($p<0.05$) higher moisture content than that of control as well as NGPMF cookies. This could be attributed to the higher amount of dietary fibers present in pearl millet, which are known to retain high moisture content. Our results are in agreement with the values observed by several workers. Dhankhar (2013) also developed gluten free cookies using coconut flour and reported approximately 5.02% moisture content.

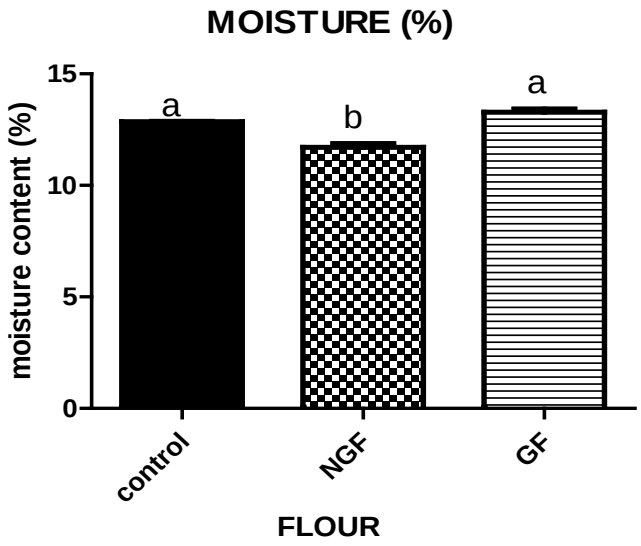


Fig 1. Moisture content of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF)

Similarly, Rai *et al.*, (2014) studied the quality characteristics of gluten free cookies prepared from the combination of pearl millet, sorghum, rice and maize flour; and reported the moisture content in the range of 3.01-4.08% in different cookies.

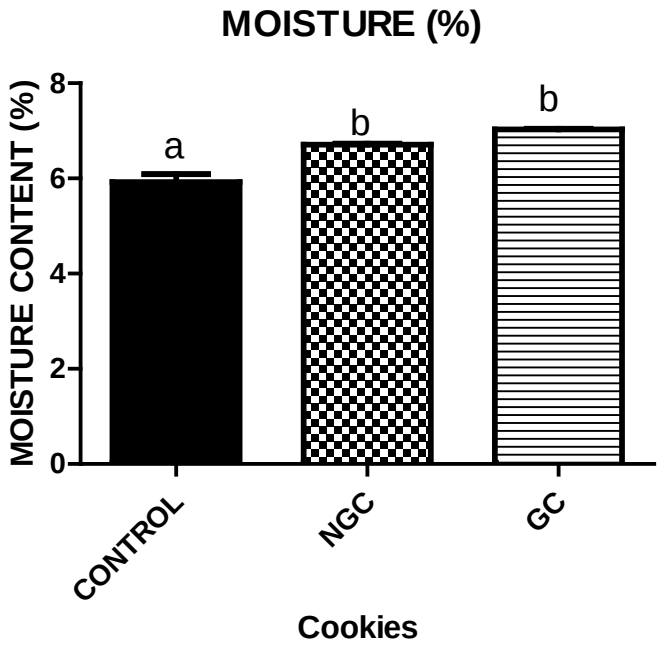


Fig 2. Moisture content of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) cookies.

Table 3: Proximate composition of Wheat Flour, non -germinated pearl millet flour, germinated pearl millet flour

Analysis	WF	NGPMF	GPMF
Moisture	12.86±0.38	11.71±0.28	13.28±0.24
Ash	0.89±0.15	2.54±0.19	1.66±0.33
Protein	10.26±0.33	11.62±0.01	15.5±0.006
Fat	1.90±0.63	4.96±0.57	4.45±0.50
Fiber	1.57±0.11	2.2±0.05	1.48±0.07
Carbohydrates	72.41±1.30	74.97±0.93	60.29±1.60

7.2. CARBOHYDRATE:

Carbohydrates are one of the important compounds in food, which provide energy for optimal growth of the body. In bakery products such as cookies, it plays a significant role in providing body and texture. In general, 70-75% carbohydrate content has been reported by several workers for cereal flours.

In the present investigation, % carbohydrate of wheat flour (control), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) is shown in Fig. 3, which indicated that carbohydrate ranged from 60.27-74.98% in different flours. It can be observed from the said figure that there was a significant difference ($p<0.05$) among the carbohydrate content of control, NGPMF and GPMF.

Germinated pearl millet flour comparatively showed lower carbohydrate content, which could be attributed to germination process. During germination, carbohydrates are utilized for the formation of rootlets. That's why lower carbohydrates content was observed in GPMF.

Carbohydrate of developed cookies is given in Fig. 4. It is clear from the graph that carbohydrate ranged from 45.40-45.61% in different cookies. Data revealed that there was a significant difference ($p<0.05$) among the carbohydrate content of control, NGPMF and GPMF cookies, which could be attributed to the difference of cereal nature as well as germination processing operation. It can also be suggested that gluten free cookies prepared from germinated pearl millet flour contained significantly ($p<0.05$) lower carbohydrate than that of control as well as NGPMF cookies.

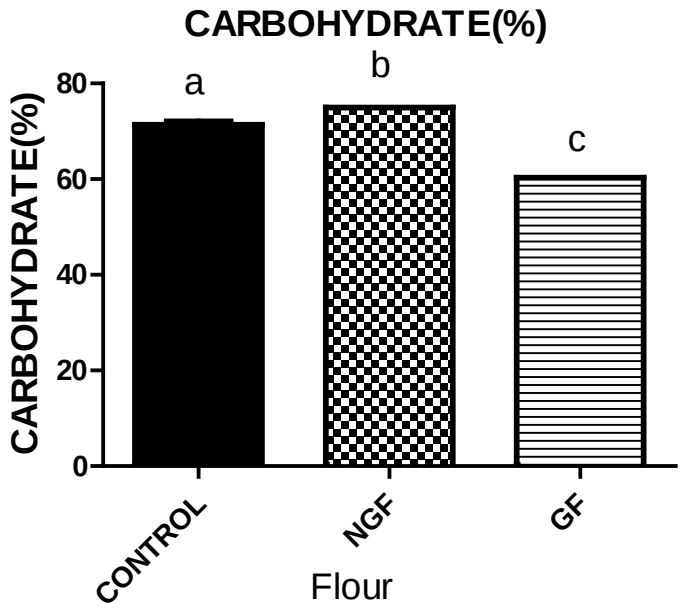


Fig 3. Carbohydrate content (%) of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF)

Our results are in good agreement with the results observed by several workers. Dhankhar (2013) also developed gluten free cookies using coconut flour and reported approximately 35.46% carbohydrate content. Similarly, Vijayakumar *et al.*, (2013) studied the quality characteristics of cookies prepared from oats and finger

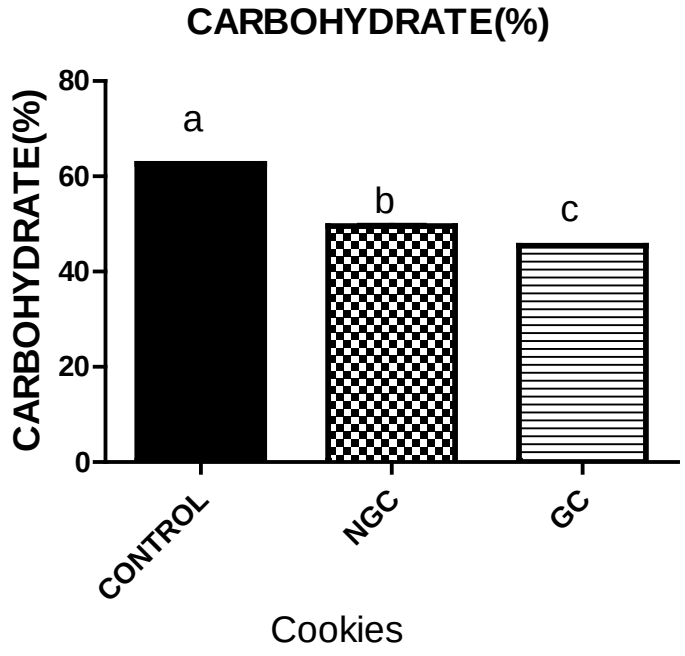


Fig. 4. Carbohydrate content of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) cookies

millet based composite flour, and reported the carbohydrate in the range of 58.23-63.84 % in different cookies.

7.3. TOTAL FAT:

Fat is a major source of energy in the diet. It acts as carrier of fat soluble vitamins and pigments. The addition of fat influences the texture as well as overall taste of cookies making it crispier because fat allows the dough to spread as it cooks on the hot cookie sheet.

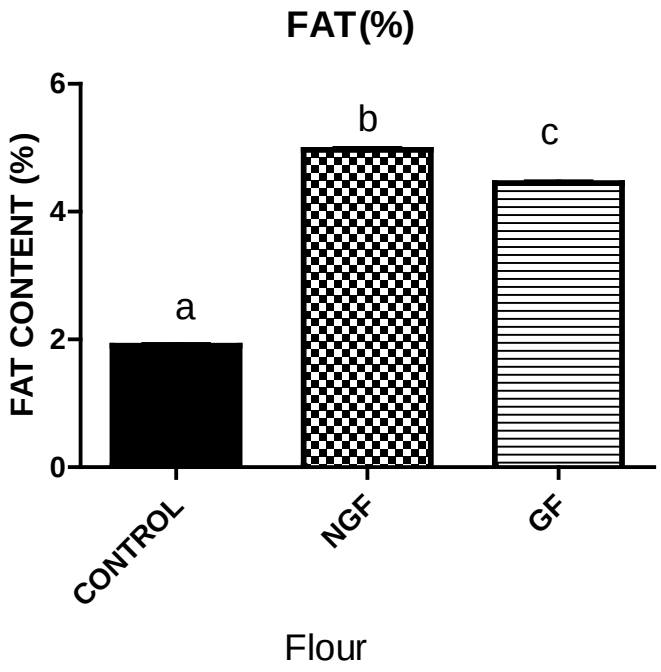


Fig. 5. Fat content of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF)

In the present investigation, fat content of control, NGPMF and GPMF is shown in Fig. 5, which indicates that fat content ranged from 1.89 to 5.00% in different flours. It can be observed from the data that there was a significant difference ($p<0.05$) among the fat of wheat flour, NGPMF and GPMF. Highest fat content was observed in NGPMF followed by GPMF and then wheat flour.

Fat content of developed cookies is given in Fig. 6. It is clear from the values that fat in the cookies ranged from 18.13 to 21.50%. Data revealed that there was a significant difference ($p<0.05$) between the fat content of control and NGPMF cookies. However, no significant difference ($p<0.05$) was observed between the fat content of WF and GPMF cookies.

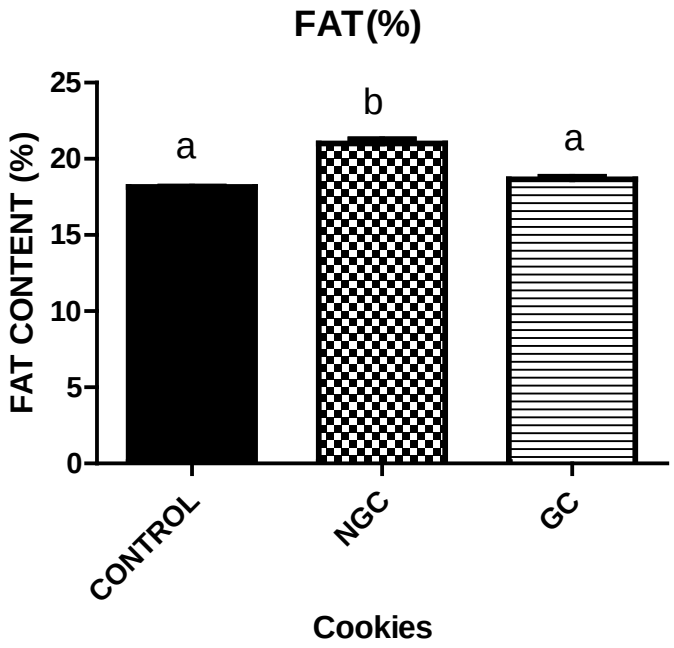


Fig 6. Fat content of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) cookies

It can also be suggested from the data that gluten free cookies prepared from germinated pearl millet flour contained significantly ($p<0.05$) lower fat content than that of control as well as NGPMF cookies. This could be attributed to the germination process as fat is utilized for seed growth during process (Sade, 2009). The results of the present study are in agreement with the values observed by several workers. Tesfaye (2010) studied the development of cookies from wheat quality protein maize and carrot composite flour, and reported the fat in the range of 13.99-15.94%. Similarly, Bassinello *et al.*, (2011) studied the characterization of cookies formulated with rice and black bean extruded flour and reported fat in the range of 10.69-16.21% in different combination of cookies.

7.4. PROTEIN:

Proteins are the building blocks of the body. It acts as a structural component of cookies. In general, 9-14% protein content has been reported by several workers in different type of cereal flours. In present investigation, protein content of control, NGPMF and GPMF is shown in Fig. 7, which indicates that protein content ranged from 10.25 to 15.51%. It can be observed from the data that there was a significant difference ($p<0.05$) among the protein content of control, NGPMF and GPMF. Protein content of developed cookies is given in Fig. 8. It is clear from the values that

protein in the cookies ranged from 9.64 to 11.72%. Data revealed that there was a significant difference ($p<0.05$) among the protein of control, NGPMF and GPMF cookies samples.

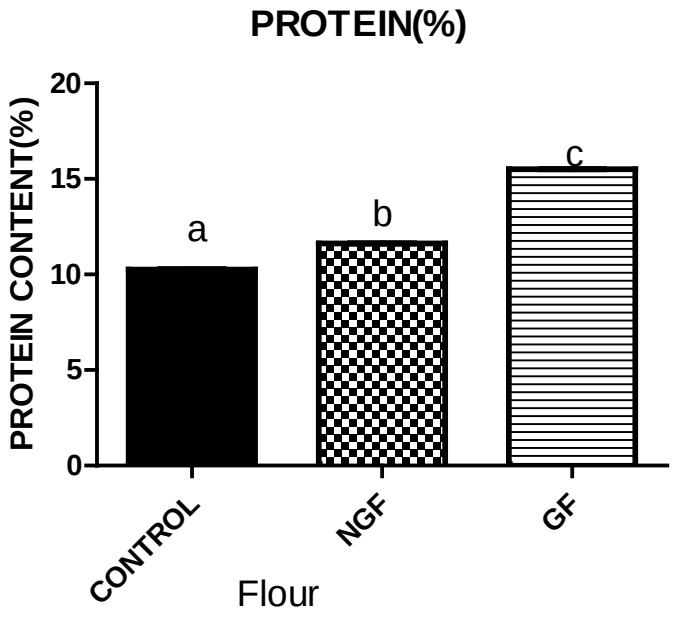


Fig. 7. Protein (%) of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) flour

It can be suggested from the data that gluten free cookies prepared from germinated pearl millet flour contained significantly ($p<0.05$) higher protein content than that of control as well as NGPMF cookies. This could be attributed to the fact that during germination process, there would be a synthesis of protein/enzymes, which are known to increase the level of protein content. Our results are in agreement with the values observed by several workers. Tesfaye (2010) studied the development of cookies from wheat quality protein maize and carrot composite flour, and reported the protein in the range of 10.89-11.60%. Similarly, Maghaydah *et al.*, (2013) studied the effect of lupine flour on baking characteristics of gluten free cookies and reported approximately 10.04-18.90% protein content. Vijayakumar *et al.*, (2013) studied the quality characteristics of cookies prepared from oats and finger millet based composite flour, and reported protein in the range of 8.30-10.12 % in different cookies.

7.5. ASH CONTENT:

Ash refers to the mineral content present in the sample. In general, 0.40-1.14% ash content has been reported in cereal flours by several workers.

In present study, ash content of control, NGPMF and GPMF is shown in Fig. 9, which indicated that ash content ranged from 0.84-2.66% in various flours.

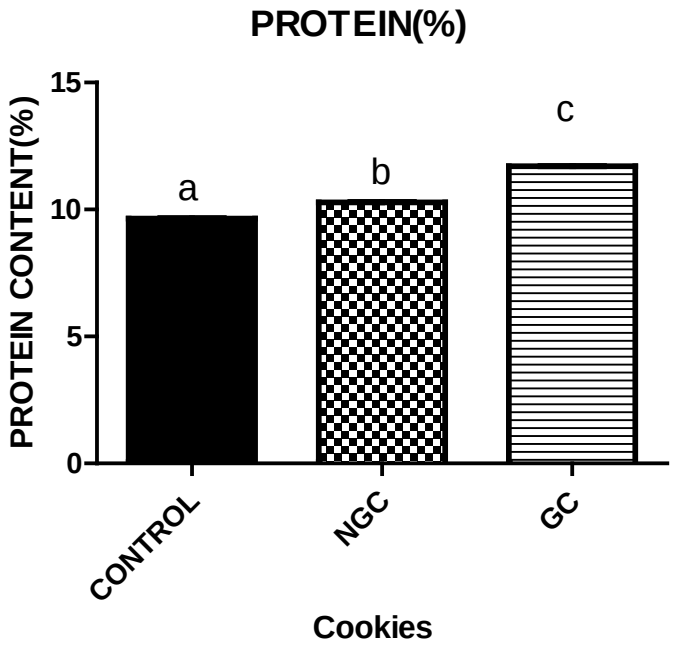


Fig. 8. Protein content (%) of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) cookies

It can be observed from the data that there was a significant difference ($p<0.05$) among the ash contents of control, NGPMF and GPMF. Ash content of developed cookies is presented in Fig. 10. It is clear from the values that ash content in the cookies ranged from 0.62 to 2.32%. Data revealed that there was a significant difference ($p<0.05$) among the ash content of cookies developed from control, NGPMF and GPMF samples, which could be attributed to the difference of cereal nature as well as minor processing operations.

It can also be suggested from the data that gluten free cookies prepared from germinated pearl millet flour contained significantly ($p<0.05$) lower ash content than that of NGPMF cookies.

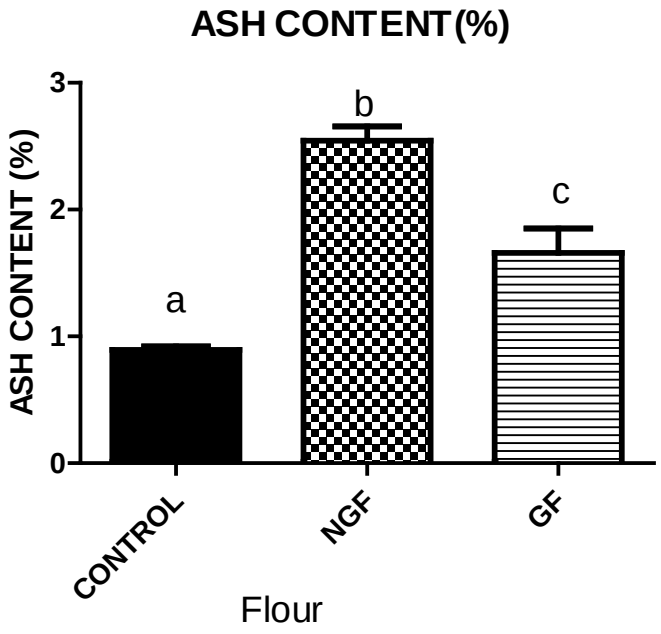


Fig. 9. Ash content of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF)

This could be due to germination process there is a mineral content lost during soaking(in water)/ germination process and the reduction was in agreement with those reported by El-Beltagy (1996) for germinated Mung seeds flour and also by El-Adawy (2002) reported for germinated chickpea flour.

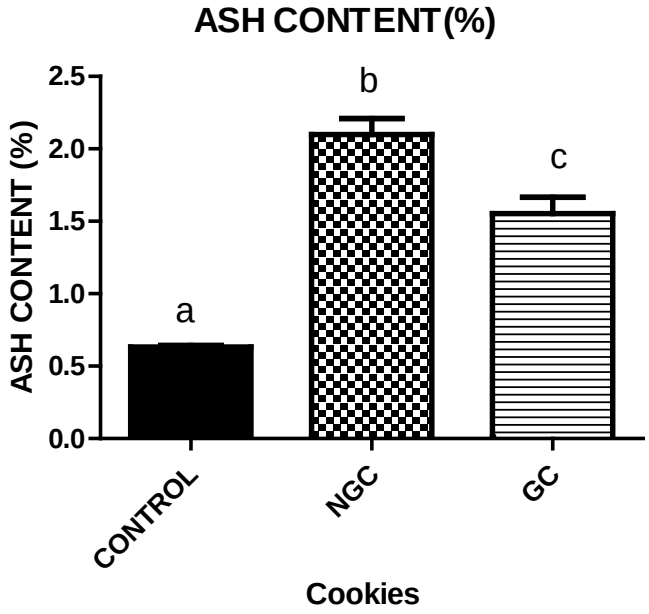


Fig 10. Ash content of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) cookies

Our results are in agreement with the values observed by several workers. Bassinello *et al.,* (2011) characterized cookies formulated with rice and black bean extruded flour and reported that ash content in the range of 0.82-2.02%. Similarly, Maghaydah *et al.,* (2013) studied the nutritional value of gluten free cookies incorporated with inulin and reported approximately 1.69-1.94% ash content. Maghaydah *et al.,* (2013) studied that effect of lupine flour on baking characteristics of gluten free cookies and reported the ash content in the range of 1.76-3.01% in different combinations of cookies.

7.6. CRUDE FIBER:

Fiber is the undigested carbohydrates in foods, which helps in maintaining normal gut motion, blood sugar level and satiety. Dietary fiber intake is also associated with lower body weight as suggested by several studies. Fiber can be characterized into two categories i.e. dietary fiber and crude fiber. Dietary fibers are the indigestible carbohydrates that do not provide energy and are even resistant to digestive enzymes. Whereas crude fiber is a part of dietary fiber that remains as a residue after the food is digested with dilute acid as well as alkali. Fiber plays an important role as they provide roughage and carries waste away from the body; and this helps in preventing constipation also.

In the present investigation, crude fiber contents of control, NGPMF and GPMF are shown in Fig. 11, which indicates that it ranged from 1.40-2.3%. It can be observed from the data that there was a significant difference ($p<0.05$) between the crude fiber content of control and NGPMF. However, no significant difference ($p<0.05$) was observed between the fiber content of control and GPMF. Crude fiber content of developed cookies is given in Fig. 12. It is clear from the values that crude fiber in the cookies ranged from 0.034-2.5%. Data revealed that there was a significant difference ($p<0.05$) among the fiber content of cookies developed from control, NGPMF and GPMF samples, which could be attributed to the difference of cereal nature as well as processing treatments.

It can also be suggested from the data that gluten free cookies prepared from germinated pearl millet flour contained significantly ($p<0.05$) higher crude fiber than that of control as well as NGPMF cookies.

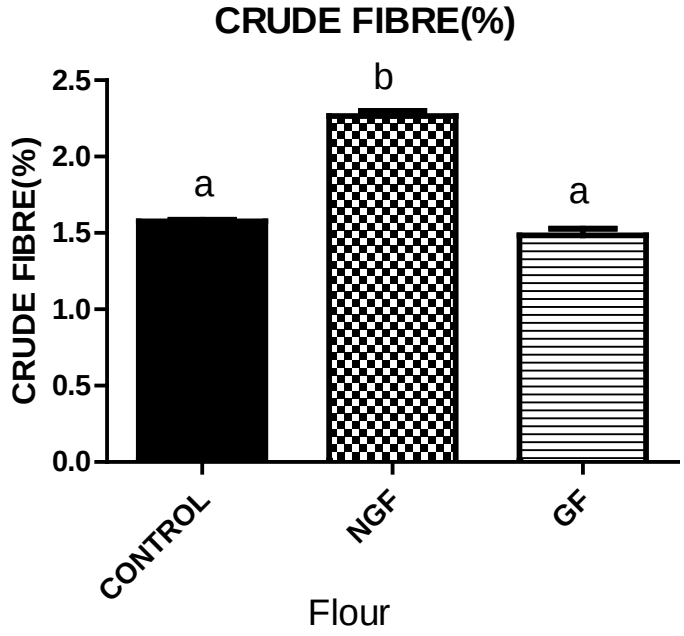


Fig. 11 Crude fiber of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) flour

This could be attributed that during germination process there will be a disappearance of starch and the crude fiber which is a major constituent of cell walls increases both in percentage and real terms, with the synthesis of structural carbohydrate, such as cellulose and hemicellulose (Peer & Leeson, 1985).

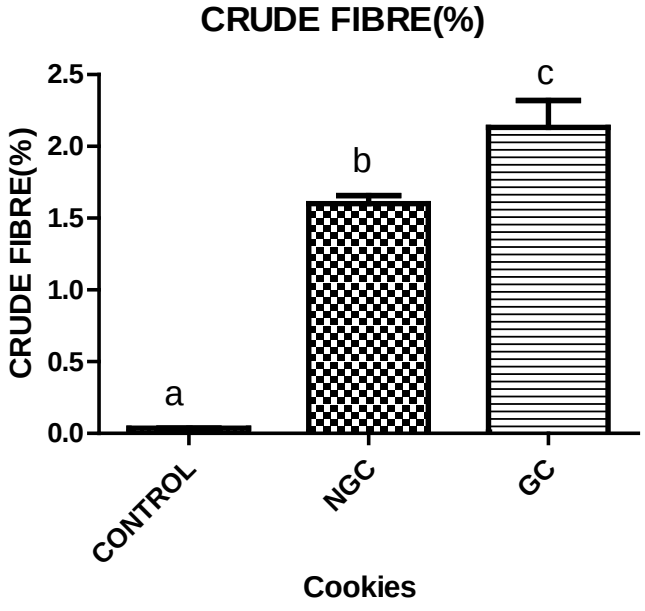


Fig. 12 Crude fiber of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) cookies

Our results are in agreement with the values observed by several workers. Maghaydah *et al.,* (2013) studied the effect of lupine flour on baking characteristics of gluten free cookies and reported 1.23-6.45% crude fiber. Similarly, Okpala and Chinyelu (2011) studied the physicochemical, nutritional and organoleptic evaluation of cookies from pigeon pea and cocoyam flour blends, and reported the crude fiber in the range of 2.20-2.86% in different combinations of cookies.

7.7. IRON CONTENT:

Iron content which present naturally in our food and it is very essential component for the hemoglobin and an erythrocyte protein which helps in transferring the oxygen from the lungs to the tissue in the body. It also essential for supporting metabolism, connective tissues and some hormone synthesis. The Recommended Dietary Allowance to meet the nutrient requirements for all healthy individuals is 97%-98%. Around 19-50 years old age people (RDA) level is 8mg for male and 18mg for female.

In the present investigation, iron contents of control, NGPMF and GPMF are shown in Fig. 13, which indicates that it ranged from 3.7-8.9mg/100g. It can be observed from the data that there was a significant difference ($p<0.05$) between the iron content of control, NGPMF and GPMF. Iron content of developed cookies is given in Fig. 14. It is clear from the values that crude fiber in the cookies ranged from 2.3-7.mg/100g. Data revealed that there was a significant difference ($p<0.05$) among the iron content of cookies developed from control, NGPMF and GPMF samples, which could be attributed to the difference of cereal nature as well as processing treatments.

It can also be suggested from the data that gluten free cookies prepared from germinated pearl millet flour contained significantly ($p<0.05$) slightly less than that of NGPMF cookies. However, there is significant difference between the iron content of control and GPMF cookies.

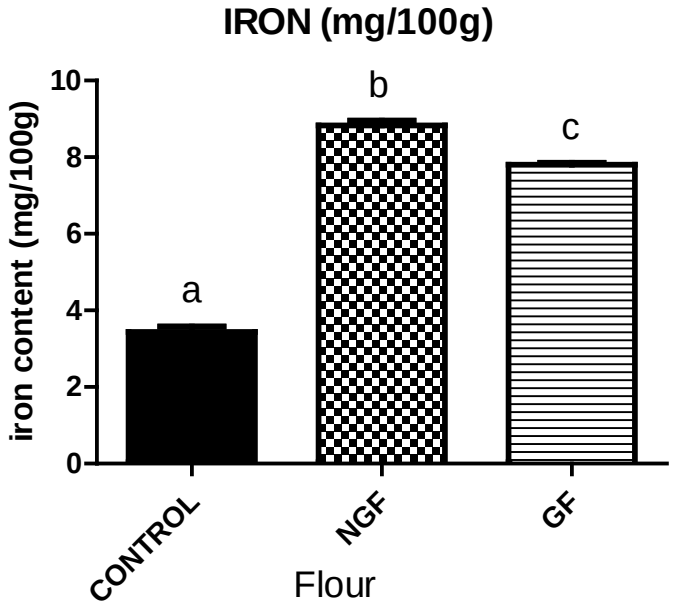


Fig. 13 Iron content of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) flour

This is because the bioavailability of iron were significantly increased due to soaking and followed by germination treatments (Afifty *et al.*, 2011).

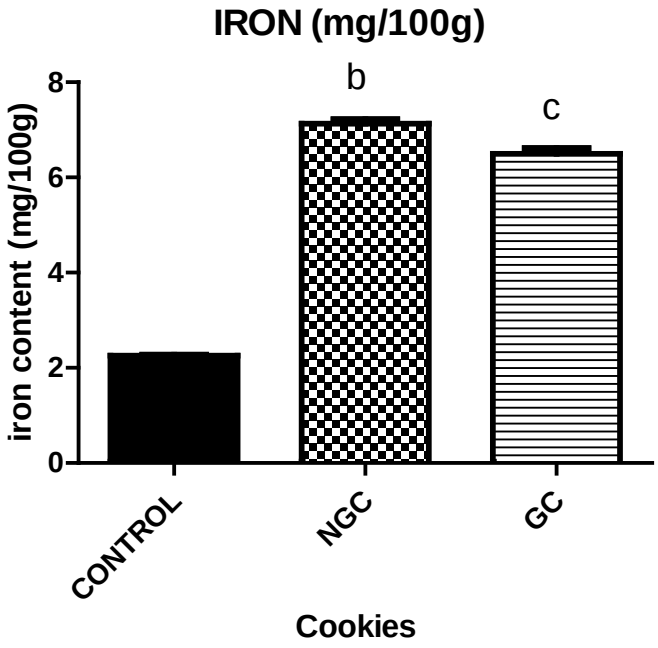


Fig. 14 Iron content of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) cookies

Our results are in agreement with the values observed by several workers. Afify *et al.*, (2012) studied effect of soaking, cooking, germination and fermentation processing on proximate analysis and mineral content three white sorghum varieties and it ranged from 3.41-7.65mg/100g. Elobeid & Berghofer (2014) studied utilization of sorghum and white bean flour for the production of gluten free and iron rich cookies and reported that it ranges from 21.3-28.6%

7.8. TANNIN CONTENT:

Tannin content is an astringency, and water polyphenols which binds to and also precipitates in to the protein, and several other organic compounds, such as amino acids and alkaloids. It decrease the intake of feed, protein digestibility, and it was considered that food rich in tannin content have low nutritional value. In recent study they have reported that the major impact of tannin rich food were having decreased efficiency for converting in absorbed nutrients to new body substances. And also reported incidence of carcinogenic, where consuming the higher quantity of tannin rich foods.

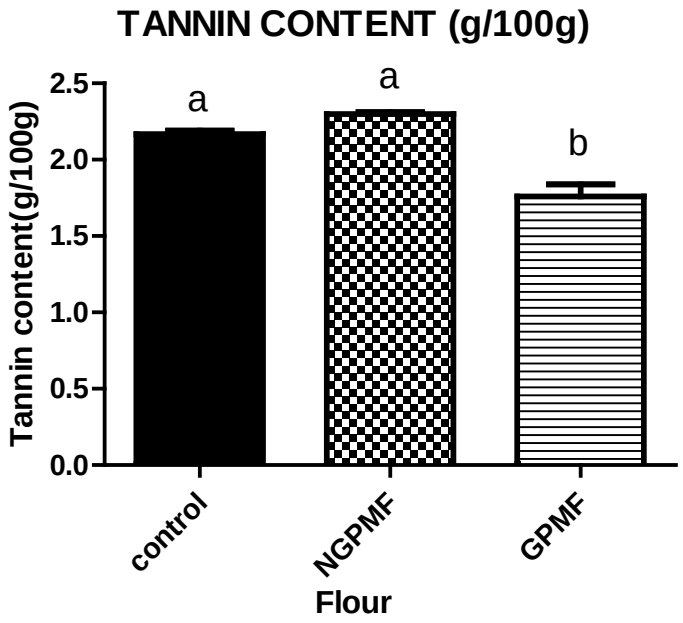


Fig 15. Tannin content of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) flour

In the present investigation, tannin contents of control, NGPMF, and GPMF are shown in Fig. 15, which indicates that it ranged from 1.61-2.18g/100g. It can be

observed from the data that there was a significant difference ($p<0.05$) between the tannin content of control, NGPMF, and GPMF. Tannin content of developed cookies is given in Fig 16. It is clear from the values that tannin content in the cookies ranged from 0.6-1.2g/100g. Data revealed that there was a significant difference ($p<0.05$) among the tannin of cookies developed from control, NGPMF and GPMF samples, which could be attributed to the difference of cereal nature as well as processing treatments.

It can also be suggested from the data that gluten free cookies prepared from germinated pearl millet flour contained significantly ($p<0.05$) less than that of NGPMF cookies. However, there is no significant difference between the tannin content of control and GPMF cookies.

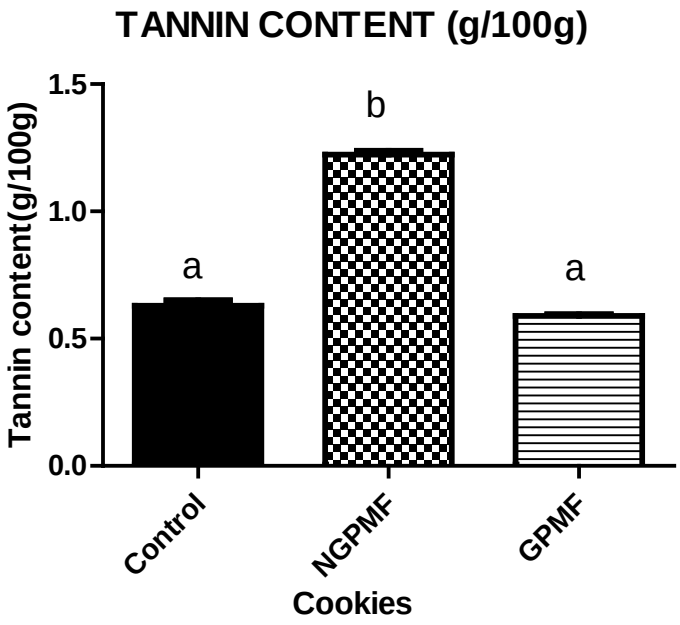


Fig 16. Tannin content of wheat flour (WF), non-germinated pearl millet flour (NGPMF) and germinated pearl millet flour (GPMF) cookies

Our results are in agreement with the values observed by several workers. Pushparaj & Urooj (2014) studied the antioxidant activity in two pearl millet cultivars as influenced by processing and reported that tannin acid ranged from 0.23-0.36g/100g in the flour. Similarly, Sade (2009) studied proximate, antinutritional factors and functional properties of processed pearl millet and reported that it ranged from 2.70-2.90g/100g which were close agreement to our values.

7.9. SENSORY EVALUATION:

Sensory evaluation was performed by semi-trained panel comprising 10 members of Department of Food Technology and Nutrition, Lovely Professional University, India. “Affective test” based on 9-point hedonic scale was done for the sensory evaluation of developed cookies. On zero day, Six combinations of cookies viz. control, NGPMC and GPMC were sensorial analyzed. The sensory scores are shown in Table 4. The data showed that , there is significant difference ($p<0.05$) in Control, NGPMC and GPMC.

Table 4. Sensory Analysis of Control, Non -Germinated Pearl Millet , Germinated Pearl Millet Cookies

Parameters	Control	NGPMC	GPMC
Color and appearance	8.7±0.8	7.30±1.14	8.0±0.6
Mouth feel	8.7±0.60	7.8±1.30	8.4±1.10
Texture	8.5±1.17	7.7±1.15	7.6±0.65
Flavour	8.8±0.76	7.67±2.51	8.6±0.80
Overall Acceptability	8.67±0.50	7.6±1.89	8.15±0.76

As in the case of colour and appearance there was a significant difference ($p<0.05$) between control, NGPMC and GPMC. The GPMC is more acceptable than that of the NGPMC.

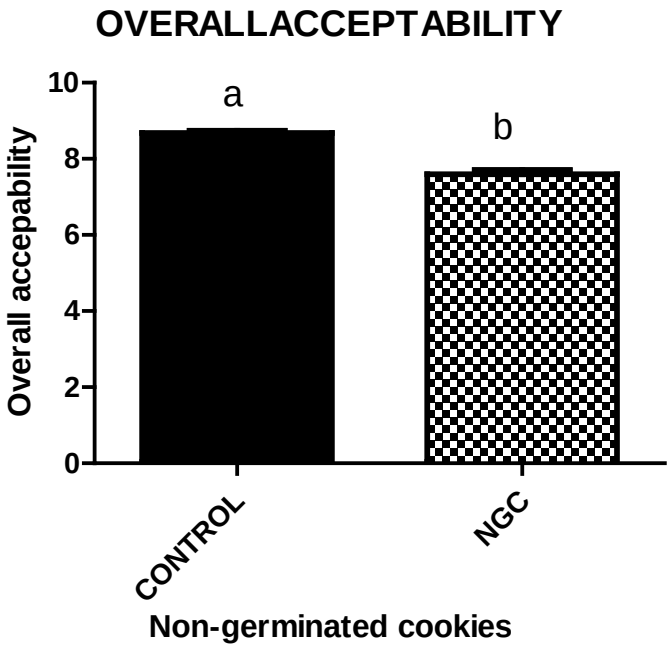


Fig 17. Overall acceptability of control *vs* non-germinated pearl millet cookies (NGPMC)

When comparing with all the other parameter the texture was low in score compared to the control (wheat flour cookies).

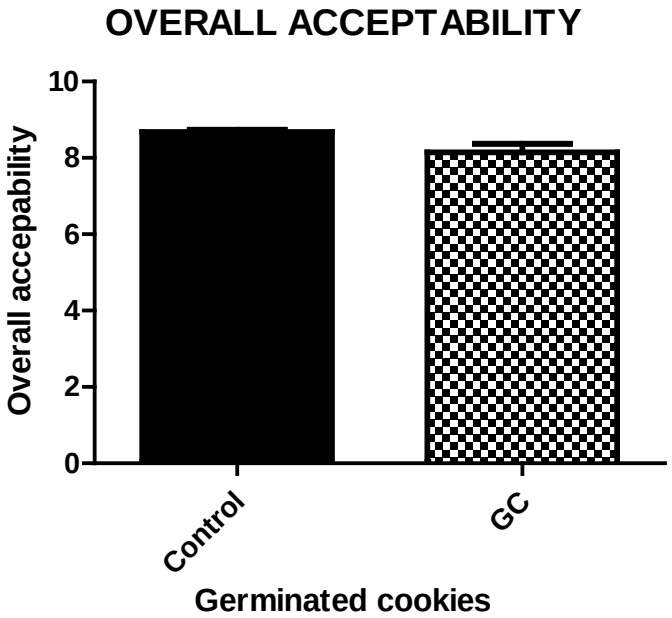


Fig 17. Overall acceptability of control *vs* germinated pearl millet cookies (NGPMC)

CONCLUSIONS

This study was aimed to develop value added bakery product by employing non- germinated pearl millet flour, germinated pearl millet flour and potato starch in order to develop gluten- free cookies. Other objective was to study the effect of germination on the levels of anti-nutritional factors such as phenols/tannins. The motive behind the development of gluten- free cookies was to prepare such a product which could be consumed on a regular basis by gluten allergic patients, who are at the risk of celiac diseases. Germination is known to reduce the anti-nutritional levels and to improve the functional properties of pearl millets. The results of the study can be concluded in the following points:

- Six different combinations viz. non-germinated pearl millet flour (NGPMF): potato starch (PS) (70:30; 60:40; 50:50), germinated pearl millet flour (NGPMF): potato starch (PS) (70:30; 60:40; 50:50) along with control (100% wheat flour) were prepared for cookies formulation. The prepared cookies were organoleptically analyzed on the basis of 9 point hedonic scale.
- Data suggested that 50:50 combination of cookies irrespective of the state of pearl millet flour was optimum and comparable to control. Therefore, this combination was selected for further physico-chemical analyses.
- Results revealed that NGPMF contained 11.71±0.28% moisture content, 2.54±0.19% ash content, 4.96±0.57% fat, 11.62±0.01% protein, 2.2±0.05% fiber, 2.30±0.34g/100g total phenols and 8.8±0.1mg/100g iron content. Similarly, GPMF contained 13.28±0.24% moisture content, 1.66±0.33% ash content, 4.45±0.50% fat, 15.5±0.006% protein, 1.48±0.07% fiber, 1.80±0.33g/100g total phenols and 7.8±0.2 mg/100g iron content.
- Gluten free cookies were prepared by using NGPMF as well as GPMF. Data suggested that moisture content, carbohydrates, fats, proteins, ash, fiber, total phenols and iron ranged from 6.71-7.03%, 45.40-49.6%, 18.6-21.0%, 10.28-11.70%, 1.55-2.10%, 1.60-2.13%, 0.59-1.20 g/100g , 6.50-7.10 mg/100g in different type of cookies.
- Germination of pearl millets improved the proteins and reduced the level of phenols in cookies. Sensory data showed that cookies prepared from GPMF had better sensory attributes and overall acceptability as compared to cookies

developed using NGPMF. Although control cookies showed significantly higher ($p<0.05$) sensory scores than that of GPMF cookies, but the later one were in acceptable range. Overall, it can be concluded that GPMF and potato starch in 50:50 ratio could be successfully used for the development of gluten free and fiber rich cookies.

BIBLIOGRAPHY

1. Agte, V. V., Khot, S., Girigosavi, S. T., Paknikar, K. M., & Chiplonkar, S. A. (1999). Comparative performance of pearl millet-and sorghum-based diets vs. wheat-and rice-based diets for trace metal bioavailability. Journal of trace elements in medicine and biology, 13(4), 215-219.
2. Afify AMR, El-Beltagi HS, Abd El-Salam SM, Omran AA(2011a). Bioavailability of iron, zinc, phytate and phytase activity during soaking and germination of white sorghum varieties. PLoS ONE 6(10):25512, 1-7.
3. Badau, M. H., Nkama, I., & Jideani, I. A. (2005). Phytic acid content and hydrochloric acid extractability of minerals in pearl millet as affected by germination time and cultivar. Food chemistry, 92(3), 425-435
4. Bassinello, P. Z., Freitas, D. D. G., Ascheri, J. L. R., Takeiti, C. Y., Carvalho, R. N., Koakuzu, S. N., & Carvalho, A. V. (2011). Characterization of cookies formulated with rice and black bean extruded flours. Procedia Food Science, 1, 1645-1652.
5. Cámara, F., & Amaro, M. A. (2003). Nutrional aspect of zinc availability.International journal of food sciences and nutrition, 54(2), 143-151
6. Chandrasekara A and Shahidi F (2011). Determination of antioxidant activity in free and hydrolyzed fractions of millet grains and characterization of their phenolic profiles by HPLC-DAD-ESI-MSn. Journal of Functional Foods, 3: 144-58
7. Chappalwar, A. M., Zanjad, P. N., Pawar, V. D., & Machewad, G. M. (2013). An investigation of oats and finger millet based cookies and their physic chemical properties. International journal of dairy technology, 63(3), 445-450.

8. Dhankhar, P., (2013). A Study on Development of Coconut Based Gluten Free Cookies.

9. Devi, P. B., Vijayabharathi, R., Sathyabama, S., Malleshi, N. G., & Priyadarisini, V. B. (2014). Health benefits of finger millet (Eleusine coracana L.) polyphenols and dietary fiber: a review. Journal of food science and technology, 51(6), 1021-1040.

10. El-Adawy, T.A., 2002. Nutritional composition and antinutritional factors of chickpeas (Cicer arietinum L.) undergoing different cooking methods and germination. Plant Food Human Nutr., 57: 83-97.

11. El-Beltagy, A., 1996. Effect of home traditional cooking on quality aspected of some legumes. MS Thesis, Faculty of Agriculture, Menofiya University, Shibin ElKom Egypt. In: Nutritional composition and antinutritional factors of mungbean seeds (Phaseolus aureus) as affected by some home traditional processes. Mubarak, A.E. (Ed.) 2005. J.Food Chem., 89: 489-495.

12. ElObeid, T., Berghofer, E., & Kerkadi, A. (2014). Production and Determination of Bioavailable Iron in Sorghum and White bean Noodles. Current Research in Nutrition and Food Science Journal, 2(1), 20-25.

13. Falola, T. (2011). Cassava Starch for Export in Nigeria during the Second World War. African Economic History, 73-98.

14. FAO (2014). FAOSTAT. Food and Agriculture Organisation of the United Nations.FAOSTAT. http://faostat.fao.org/site/339/default.aspx

15. Hulse, J. H., Laing, E. M., & Pearson, O. E. (1980). Sorghum and the millets: their composition and nutritive value. Academic Press

16. Hithamani, G., & Srinivasan, K. (2014). Effect of domestic processing on the polyphenol content and bioaccessibility in finger millet (Eleusine coracana) and pearl millet (Pennisetum glaucum). Food Chemistry, 164, 55-62.

17. Inyang, C. U., & Zakari, U. M. (2008). Effect of germination and fermentation of pearl millet on proximate, chemical and sensory properties of instant "fura"-A Nigerian cereal food. Pakistan Journal of Nutrition, 7(1), 9-12.

18. Issoufou, A., Mahamadou, E. G., & Guo-Wei, L. (2013). Millets: nutritional composition, some health benefits and processing—A review. Emirates Journal of Food and Agriculture, 25(7), doi-10.

19. Jaybhaye, R. V., Pardeshi, I. L., Vengaiah, P. C., & Srivastav, P. P. (2014). Processing and technology for millet based food products: a review. Journal of Ready to Eat Food, 1(2), 32-48.

20. Kumar, A. L. P. A. N. A., & Chauhan, B. M. (1993). Effects of phytic acid on protein digestibility (in vitro) and HCl-extractability of minerals in pearl millet sprouts. Cereal chemistry, 70, 504-504.

21. Makharia, G. K., Verma, A. K., Amarchand, R., Bhatnagar, S., Das, P., Goswami, A., .. & Anand, K. (2011). Prevalence of celiac disease in the northern part of India: a community based study. Journal of gastroenterology and hepatology, 26(5), 894-900.

22. Mariac et al., (2006). Agroecosystems: soils, climate, crops, nutrient dynamics and productivity. CRC Press.

23. Murty & Kumar (1995). Genetic enhancement of pearl millet and sorghum for the semi-arid tropics of Asia and Africa. Genome, 42(4), 617-628.

24. Michaelraj, P. S. J., & Shanmugam, A. (2013). A Study on Millets Based Cultivation and Consumption in India. International Journal of Marketing, Financial Services & Management Research, 2(4), 49-58.

25. Maghaydah et al., (2013) effect of lupine flour on baking characteristics of gluten free cookies .Advance Journal of Food Science and Technology, 5(5):600-605

26. Nambiar, V. S., Dhaduk, J. J., Sareen, N., Shahu, T., & Desai, R. (2011). Potential Functional Implications of Pearl millet (Pennisetum glaucum) in Health and Disease

27. Okpala, L. C., & Chinyelu, V. A. (2011). Physicochemical, nutritional and organoleptic evaluation of cookies from pigeon pea (Cajanus cajan) and cocoyam (Xanthosoma sp) flour blends. African Journal of Food, Agriculture, Nutrition and Development, 11(6).

28. Pushparaj, F. S., & Urooj, A. (2014). Antioxidant activity in two pearl millet (Pennisetum typhoideum) cultivars as influenced by processing. Antioxidants,3(1), 55-66.

29. Rathi, A., Kawatra, A., & Sehgal, S. (2004). Influence of depigmentation of pearl millet (Pennisetum glaucum L.) on sensory attributes, nutrient composition, in vitro protein and starch digestibility of pasta. Food chemistry,85(2), 275-280.

30. Rai, S., Kaur, A., & Singh, B. (2014). Quality characteristics of gluten free cookies prepared from different flour combinations. Journal of food science and technology, 51(4), 785-789.

31. Sade, F. O. (2009). Proximate, antinutritional factors and functional properties of processed pearl millet (Pennisetum glaucum). Journal of Food Technology,7(3), 92-97.

32. Sakač, M., Mandić, A., Mišan, A., Tumbas, V., & Hadnađev, M. (2014). Assessment of antioxidant activity and rheological properties of wheat and buckwheat milling fractions. Journal of Cereal Science, 54(3), 347-353.

33. Surekha, N., Naik, R. S., Mythri, S., & Devi, R. (2013). Barnyard Millet (Echinochloa frumentacea Link) Cookies: Development, value addition, consumer acceptability, nutritional, and shelf life evaluation. IOSR Journal of Environmental Science, Toxicology and Food Technology, 7(3), 1-10.

34. Tripathi, B., & Platel, K. (2013). Feasibility in fortification of sorghum (Sorghum bicolor L. Moench) and pearl millet (Pennisetum glaucum) flour with iron. LWT-Food Science and Technology, 50(1), 220-225

35. Vijayakumar., & John, S. quality characteristics of oats and finger millet flour based cookies and Nutritional properties Food Science and Technology, 50(2).

36. Zhu, F. (2014). Structure, physicochemical properties, and uses of millet starch. Food Research International, 64, 200-211

APPENDIX

SCORE CARD

NAME OF PRODUCT: *GLUTEN FREE COOKIES*

NAME OF EVALUATOR:

YOU ARE REQUESTED TO EVALUATE THE PRESENTED FORMULATION OF GLUTEN FREE COOKIES BASED ON 9-POINT HEDONIC SCALE AS PER FOLLOWING:

Hedonic Scale:

Expression	Points to be assigned
Liked extremely	9
Liked very much	8
Liked moderately	7
Liked slightly	6
Neither liked nor disliked	5
Disliked slightly	4
Disliked moderately	3
Disliked very much	2
Disliked extremely	1

SAMPLE	COLOR & APPEARANCE	BODY & TEXTURE	MOUTH FEEL	FLAVOUR	OVERALL ACCEPTIBILITY
PT_Z					
PT_X					
PT_Y					

REMARKS:

SIGNATURE:

THANK YOU