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Preparation and Quality Evaluation of Cookies Incorporated with Chickpea and Corn Flour

Aakriti Kuikel
Kinesiology, Health, Food & Nutritional Sciences Department
University of Wisconsin, Stout
Menominie, WI, USA
kuikela0733@my.uwstout.edu

Yaman Pandey
Department of Automotive and Manufacturing Engineering
Minnesota State University, Mankato
Mankato, MN, USA
Yaman.pandey@mnsu.edu

Pawan Bhandari, Ph.D.
Professor
Department of Automotive and Manufacturing Engineering
Minnesota State University, Mankato
Mankato, MN, USA
Pawan.bhandari.2@mnsu.edu

Abstract

This study was to investigate the effects of wheat flour substitution with legume flour and maize flour in cookies for physiochemical properties. Cookies made with chickpea and maize flour were developed with the goal of producing a healthy and nutritious snack. Study demonstrated that cookies made with composite flour formulation including legumes and maize flour had softer textures and better protein and carbohydrate digestion. It has been investigated to boost the protein content of cookies made with typical wheat flour by partially substituting protein-rich flours, such as chickpea and maize flour, for refined wheat flour. The formulation using wheat flour and chickpea flour was regarded as the control sample, and optimization involved adding maize flour in various proportions to wheat flour and chickpea. The formulations of cookies were prepared from (a) Control (80:20 wheat flour: Chickpea flour), (b) S1(75:20:5 wheat flour: Chickpea flour: maize flour), (c) S2(70:20:10 wheat flour: Chickpea flour: maize flour), (d) S3 (65:20:15 wheat flour: Chickpea flour: maize flour), (e) S4 (70:20:20 wheat flour: Chickpea flour: maize flour). The moisture, protein, fat, ash content, crude fiber, and carbohydrate of control cookies and maize flour incorporated cookies was found to be 1.59%, 7.03%, 22.14%, 0.99%, 0.57%, 69.19% and 1.64%, 8.36%, 20.59%, 1.19%, 1.54%, 67.68% respectively. Similarly, the calcium content of control cookies and best sample was found to be 65.98%, and 69.59% respectively. These findings suggest that corn flour can be incorporated for value addition of product without any adverse effect on sensory attributes. At 5% level of significance, protein and crude fiber of control and product were found to be significantly different between control and best formulated sample.

Keywords
Quality Evaluation, Cookies, Chickpea, Corn Flour

1. Introduction

1.1 General Introduction

Cookies are commonly consumed in most parts of the world and represent the largest category of snack foods (Igbabul et al. 2015). Cookies are the most popular baked items consumed among all age groups in many countries because they have a very acceptable taste and their low water activity allows a long shelf life. They are the products usually dried to low moisture content (Ubbor et al. 2022). Cookie is an American English name, which was derived from the Dutch word 'koekje' which means 'little cake'. Cookies are nutritive snacks produced from unpalatable dough that is transformed into appetizing products through the application of heat in an oven. They are ready-to-eat, convenient and inexpensive food product, containing digestive and dietary principles of vital importance. Cookies are ideal for nutrient availability, palatability, compactness and convenience. They differ from other bakery products like bread and cakes because of having low moisture content, comparatively free from microbial spoilage and long shelf life of the product (Kishorgoliya et al., 2018). Cookies contribute valuable quantities of iron, calcium, protein, calorie, fiber and some of the B-vitamins to our diet and daily food requirement (Ikuomola et al., 2017). Cookies are forms of confectionary. Nowadays, Baked products are considered as excellent vehicle for fortification, value addition and feeding at mass scale. Baked products are the most important sources of dietary fibre in total food consumption (Mishra et al.,2012).

Legumes are richer in proteins (18–24%) than cereal grains and contain certain amino acids such as lysine, tryptophan or methionine. Considering the above, increasing supplementation of wheat flour with other healthier flours is observed.

Chickpea (Cicer arietinum L.) is a fine example which is commonly called gram, Bengal gram, or garbanzo bean is an important pulse crop grown and consumed all over the world, especially in the Afro-Asian countries. It is a good source of carbohydrates and protein, and protein quality is better than other pulses (Jukanti et al., 2012). Chickpea flour, the main component of chickpea is an oligosaccharide called stachyose that constitutes 75–76% of the total raffinose-family sugars. In addition, chickpea is a source of folic acid, tocopherols, sterols, carotenoids (especially β-carotene) It is rich in B-group and F-group vitamins and many microelements: potassium, phosphorus, magnesium, zinc, selenium, manganese and even copper. On average, chickpea seeds contain 23% of highly digestible protein, 64% total carbohydrate, 47% starch, 5 % fat, 8 % crude fiber, and 3.6 % ash. Due to its importance as an affordable protein source in developing nations, it is crucial to obtain and maintain higher yields of the chickpea crops (Ahmad et al. 2005).

Corn (Zea mays L) is the world's most widely used cereal in the production of supplementary foods Maize has a multitude of uses and ranks second to wheat among the world's cereal crops in terms of production. This use involves several processing steps such as fermentation, roasting and dehulling. These processes are either applied alone or in combination, and are accompanied by the modification of the nutritional, functional and rheological characteristics of the flour obtained (Dongmo et al., 2020). Types of corn include sweet, popcorn, dent and flint, which is also used as animal or human feed. Although white or yellow corn are the most commonly consumed varieties compared to red, blue, purple and orange. Maize could be cook or grind in a process called Nixtamalization. It is a major source of corn starch (maize flour), which is a major ingredient in home cooking and in many industrialized food products. Maize also is a major source of cooking oil and gluten. Maize starch can be hydrolyzed and enzymatically treated to produce syrups, a sweetener; which is also fermented and distilled in order to produce grain alcohol (Oladapo et al., 2017).

White corn provides numerous health benefits due to the presence of quality nutrients within. Besides being a delicious addition to any meal, it is rich in phytochemicals and offers protection against several long-lasting diseases. White corn flour is a food commodity with limited use (Hunaefi et al., 2021). Corn flour can be used as the primary raw material in the production of cookies. The main benefit of corn flour as a food ingredient is its higher level of dietary fiber in comparison with wheat flour (Aini et al., 2022). Maize consists of 70-87% (carbohydrates) starch (amylose and amylopectin), 6-13% protein. 4% fat, 2-6% oil 1-3% sugar. Additionally, maize is rich in riboflavin, phosphorus, potash, iron, calcium, zinc, and vitamin B. Yellow maize has a high amount of vitamins (carotenoids), while blue, purple, and red variety is rich in antioxidants and phenolic compounds beneficial for the gut. Fiber helps our body remove toxins. Corn's protein content is high. This can benefit vegetarians and vegans since they do not consume protein from meat resources.

1.2 Statement of problem

What really instigated this study on preparation and quality evaluation of nutritious cookies with corn flour and wheat flour blends was for achieving an ideal balance between taste, texture, and nutritional value Hence, this triggers research efforts towards the application of nutritious underutilized raw materials to produce nutritious snack foods. While refined wheat flour does contain some nutrients, the refining process removes a significant portion of the grain's nutritional content. The reduction or replacement of wheat flour integrating chickpea and corn flour into the cookie recipe, can provide an alternative. Most commercially available wheat flour cookies still lack significant amounts of fiber, so incorporation of corn flour and chickpea can minimize any negative sensory or quality attributes maintaining overall consumer acceptability. The goal was to create cookies that have a pleasant flavor profile, a desirable texture, and improved nutritional composition by leveraging the unique properties of each flour. So, Protein rich cookies can be prepared from the flours such as wheat flour mixed with corn flour, chickpea, or other protein rich ingredients.

Cookies have the potential to be a significant contributor of essential nutrients in the human diet (Akpapunam and Darbe 1994). This is primarily because cookies are very popular and well accepted by consumers including children (Zoulias et al., 2000). Therefore, cookies can be a good source of nutrient for children. Cookies have a long shelf-life and can be produced on a large scale for wider distribution (Hoojjat and Zabik 1984). A successful way to improve the nutritional aspect of cookies is by preparing cookies with enriched flour (Hoojjat and Zabik 1984).

1.3 Objectives

1.3.1 General Objective

The general objective of this study was the preparation and quality evaluation of cookies incorporated with chickpea and corn flour blends.

1.3.2 Specific Objectives

1. To carryout proximate analysis of wheat flour, chickpea flour and corn flour.
2. Determine the optimal ratio and proportion of wheat, chickpea, and corn flour in the cookie recipe to achieve the desired texture, taste, and nutritional profile.
3. To perform the sensory evaluation of the product with varying amount of wheat and corn flour and select the best sample for further analysis.
4. To evaluate the cost of the best product.

2. Materials and Methods

2.1 Study site and raw Material

The study was conducted in the laboratory of College of Applied Food and Dairy Technology. The raw ingredients required to make cookies were gathered. From the Kathmandu market, refined wheat was purchased. The other items, including bagged white maize flour from Jumla and kabuli-variety chickpeas, were also bought at a local market in Machhapokhari, Kathmandu. The additional supplies, which included butter, ghee, sugar, salt, baking powder, and eggs, were purchased at the Kumaripati neighborhood market. Glassware, kitchenware, chemicals, and other necessary supplies were taken from the CAFODAT laboratory. The CAFODAT laboratory also supplied the polyethylene bags that were used to package the biscuits.

2.2 Methods

2.2.1 Preparation of Chickpea Flour

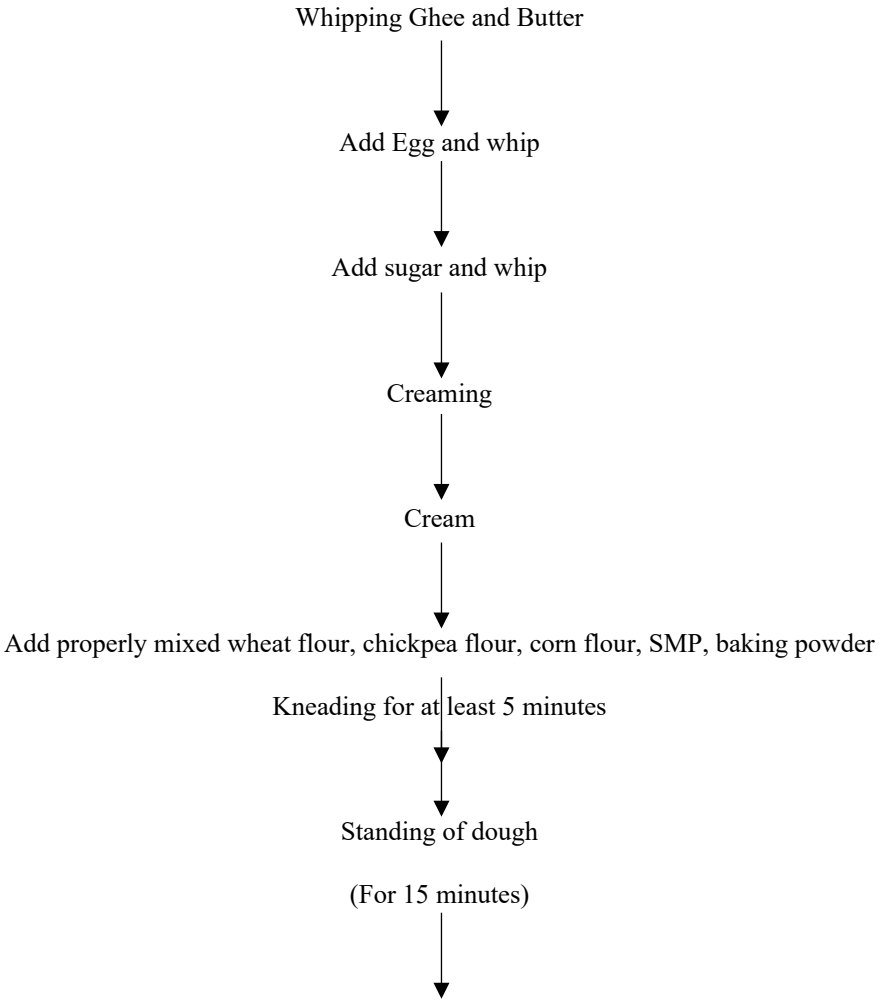
The husk of chickpea flour was removed completely manually by rubbing the soaked chickpea. The split dehulled chickpea that occurred after husk removal was then spread out in a dehydrator tray to dry. The chickpea was then dried for 2 days at 40°C in a dehydrator. The grinder was then used to turn the dried chickpeas into flour. Later, it was packed in polybags after being sieved through a sieve with a 20-mesh size.

Table 1**:** Recipe Formulation for Cookies

SN	Ingredients	Control (g)	S1(g)	S2 (g)	S3 (g)	S4(g)
1	Wheat Flour	80	75	70	65	60
2	Chickpea Flour	20	20	20	20	20
3	Corn Flour	0	5	10	15	20
4	Salted Butter	1.5	1.5	1.5	1.5	1.5
5	Ghee	35	35	35	35	35
6	Sugar	40	40	40	40	40
7	Egg	15	15	15	15	15
8	Milk Powder	2	2	2	2	2
9	Baking Powder	1	1	1	1	1

2.2.2 Method of preparation

Raw materials were weighed as per the calculated recipe as given in Table 1. Then after creaming up of ghee, butter, sugar, and egg was done till the mixture appeared creamy. The mixing was done in mixing machine at top speed for 3-5 minutes as per requirement. Then, to create a soft dough, all the dry ingredients that had been thoroughly combined were added (Figure 1).



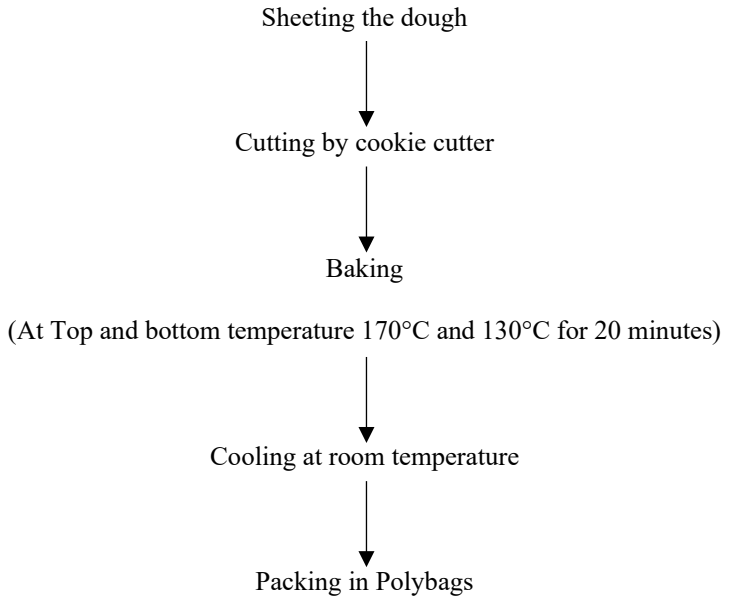


Figure 1: Preparation of Chickpea and Corn Flour incorporated cookies

Now, thus prepared dough was left for 15 minutes for laying, in order to achieve maturity of dough for easy machinability and good surface gloss. Dough was rolled into a sheet after resting, and a cookie cutter was used to give it a round shape. The tray containing the shaped cookies was then placed in the oven, which was set to bake them for 20 minutes at top and bottom temperatures of 170°C and 130°C respectively.

Baked biscuits were now cooled for 20 minutes and then packed in poly bags and stored in a cool and dry place for further analysis.

2.3 Analytical Procedures

Physiochemical analysis of raw material and products were carried out through following methods:

2.3.1 Determination of moisture content

Moisture content of the sample (5g) was determined by weight loss during heating in a thermostatically controlled oven at 105° C by hot air oven method as described in Rangana (2014). The final reading was taken after 3 hrs.

2.3.2 Determination of ash content

The total ash content was determined as per (AOAC, 2005). The sample was weighed in crucible and placed in muffle furnace for overnight.

2.3.3 Determination of crude fat

The crude fat was determined by solvent extraction method as per (Rangana, 2014). 7g sample was weighed and the fat content was determined by ether extraction method. The process was carried out for 4 hours (for 25 cycles).

2.3.4 Determination of Crude fiber

The crude fiber content was determined as per (Rangana, 2014). For fiber, 5 g sample was boiled with acid and base and made it acid and base free and dried in hot air oven.

2.2.5 Determination of Crude Protein

The crude protein was determined by Kjeldahl method as per (AOAC, 2005). Protein content was analyzed by Kjeldahl micro analysis. The final result was calculated after titration with 0.01N HCL.

2.3.6 Total Carbohydrate

The total carbohydrate was determined by differential methods.

Carbohydrates (%) = 100 - (sum of % moisture, crude protein, total ash, crude fiber and crude fat)

2.3.7 Calcium Content
The calcium content was determined by titration method as described in (Rangana, 2014). For calcium, sample ash is precipitated as calcium oxalate. The precipitate is dissolved in hot dilute H_2SO_4 and titrated with $KMno_4$.

2.3.8 Weight
The cookies were selected randomly; weighed using analytical balance as described in (Noor Aziah *et al.*, 2012).

2.3.9 Thickness
To determine the thickness (T), six cookies were placed on top of one another. The total height was measured in millimeters with the help of ruler. This process was repeated get an average value and results were reported in mm as described in (Soni *et al.*, 2018).

2.3.10 Diameter
To determine the diameter (D), six cookies were placed edge to edge. The total diameter of the six cookies was measured in mm by using a ruler. The cookies were rotated at an angle of 90^o for duplicate reading. This was repeated once more and average diameter was reported in millimeters as described in (Soni *et al.*, 2018).

2.3.11 Spread Ratio
Spread factor (SF) was determined from the diameter to thickness ratio as described in (Soni *et al.*, 2018).

2.3.12 Density
After calculating the volume of cookies, density of them was obtained by ratio of mass to volume as described by (Jemziya & Mehendran 2017).

Density (kg/m^3) = Mass of cookie (kg)/ Volume of Cookie (m^3)

2.4 Sensory Evaluation
Five different cookies were prepared by using different proportions of wheat flour and corn flour while the proportion of chickpea remained constant. The sensory evaluation for overall quality was carried out with 10 semi- trained panelists including teachers, research students and students of CAFODAT. The parameters for sensory evaluation were color, flavor, crispness, texture and overall acceptability. Sensory evaluation was performed by hedonic rating test. All the scores in the evaluation sheet were summed up and the statistical method was used to find the best product.

2.4 Statistical Analysis
All the experiments were carried out in triplicates. The experimental data were analyzed using one-way ANOVA (Analysis of Variance) and t-test using the statistical Analysis system SPSS (Statistical package for social science) 16.0 program. Significant levels were defined as probabilities of 0.05 level of significance. All processing treatments were triplicates. The means are treated with ANOVA and seen if there was significantly different among products using Duncan the best treatments were selected.

3. Results and Discussion
The wheat flour, chickpea and corn flour were collected and mixed with other ingredients to formulate corn flour incorporated cookies of 5%, 10%, 15% and 20% of corn flour incorporation. Proximate composition of the flour as well as cookies was carried out. The best product among the three variations was determined by carrying out sensory evaluation. The sensory attributes for corn flour incorporated cookies were color, texture, taste, crispiness and overall acceptability.

3.1 Analysis of raw materials
3.1.1 Physiochemical analysis of wheat flour, chickpea flour, and corn flour
From the above result, the moisture content, protein, fat, total ash, crude fiber, carbohydrate, and calcium of wheat flour were found to be 13.41%, 10.63 %, 0.92%, 0.68%, 0.27 %, 85.15%, and 21.57mg/100g respectively. The obtained values are in the range according to the value stated by (DFTQC, 2017) whose value are 13.3% for moisture content,

11% for protein, 0.9% for fat, 0.6% for ash 0.3% for fiber, 73.9% for carbohydrate and 23mg/100g respectively (Table 2).

Table 2: Analysis of Raw ingredients

Parameters	Wheat Flour	Chickpea Flour	Maize Flour
Moisture Content (%)	13.41±0.16	9.78±0.2	11.75±0.22
Protein (%)	10.63±0.24	21.91±0.39	9.79±0.11
Fat (%)	0.92±0.12	6.57±0.15	3.88±0.12
Ash (%)	0.68±0.005	3.01±0.1	1.45±0.05
Crude Fiber (%)	0.27±0.01	1.3±0.01	1.75±0.06
Carbohydrate (%)	85.15±0.17	67.32±0.38	84.98±1.39
Calcium (mg/100g)	21.57±1.27	49.34±0.34	20.33±1.49

*Values are the means of triplicate data. ± Figures are on standard deviation.
* Except for moisture content, all of the aforementioned statistics are in dry basis.

The moisture content, protein, fat, total ash, crude fiber, carbohydrate, and calcium of chickpea flour were found to be 9.78%, 21.91, 6.57%, 3.01%, 1.3%, 67.32%, 49.34mg/g respectively. The obtained values are in range according to the value stated by (DFTQC,2017) whose value are 9.9%, 20.8%, 5.6%, 2.7% ,1.2%, 59.8%. except for calcium. Since the shell of the chickpea was removed to make the flour, some calcium may have been lost. According, the standard calcium content of chickpeas is 56 mg/g.

Similarly, the moisture content, protein, fat, total ash, : fiber, carbohydrate, and calcium of corn flour were found to be 11.75%, 9.79%, 3.88%, 1.45%, 1.75%, 84.98%, and 20.33mg/100g. The obtained values are in range according to the value stated by (DFTQC,2017) whose value are 12%, 9.2%, 3.9%, 1.2%, 1.6%, 73.7%, and 20mg/g respectively. Varieties, climatic conditions, soil type, maturity, fertility, processing methods and other factors may contribute to differences in proximate composition.

3.2 Sensory evaluation of corn flour incorporated cookies

The sensory evaluation of the cookies made with various levels of maize flour incorporation was conducted. Ten semi-trained panelists received the samples. The panelists, who were only semi-trained, provided their opinions about the cookies color, flavor (taste and fragrance), texture, crispiness, and general acceptability. It was advised that the panelists give their opinions as scores on the score sheets. Rangana (2014)'s Hedonic scale rating exam was used to evaluate the senses.

The brief result of sensory evaluation of Cookies was depicted in bar diagram (Figure 2).

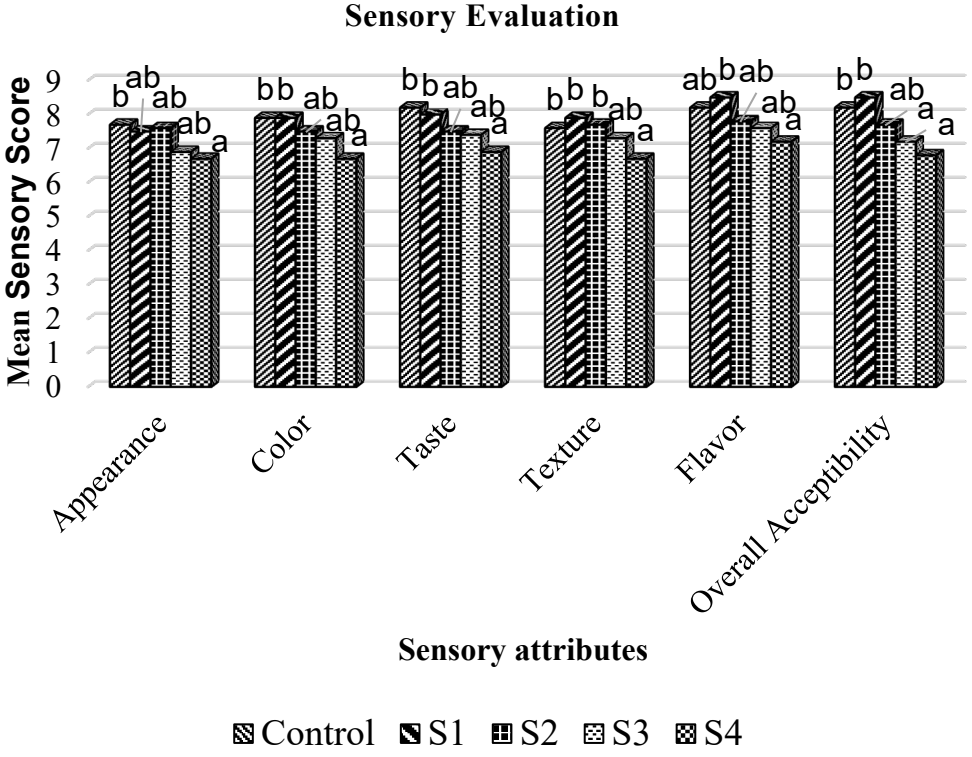


Figure 2: Sensory evaluation of cookies

The graph shows the sensory composite score for each of the five samples. S1 and S4 differ from the Control sample differ significantly in terms of appearance. The Control sample and S1 are all notably different from S4 in terms of color. Control sample and S1 are all remarkably different from S4 in terms of taste. Control, S1, S2 and S3 differ greatly with S4 in terms of texture. But in terms of flavor, S2 and S3 differ greatly with S4. Control, S1, differ from S3 and S4 greatly.

3.2.6 Overall acceptability

Regarding overall acceptability, control sample, S1, S2, S3, and S4 received the mean scores of 8.2, 8.5, 7.7, 7.2, and 6.8 respectively. Control sample and S1 had the highest level of approval for overall acceptability and S4 had the lowest level of approval. Graph in image also depicts that control sample, S1 differs significantly from S3 and S4 while control and S1 are significantly same. Similarly, sample S3 and S4 does not differ significantly. According to (Ortíz-Fernández, 2019), maize flour contains starch, and the starch content can impact the texture and sensory attributes of cookies. The addition of maize flour may have altered the starch composition of the cookie dough, resulting in changes in texture, crispiness, and mouthfeel. Different proportion of maize flour in the study mentioned above had a similar effect like mentioned by to (Ortíz-Fernández, 2019), on the overall acceptability of the cookies.

3.3 Analysis of corn flour incorporated and control cookies

Incorporated cookies' taste study reveals that formulation S1 with 5 parts maize flour outperformed formulations S2, S3 and S4. Table 3 below provides the chemical breakdown of an incorporated cookies that contains 5 parts corn flour and 75, 20 parts of wheat flour and chickpea flour respectively.

3.3.1 Analysis of maize flour incorporated and control cookies

Proximate composition and micronutrient analysis of selected corn flour incorporated cookies and control cookies. The proximate analyses are calculated on the basis of percentage (%) and micronutrients are calculated on the basis of (mg/100g).

Table 3: Analysis of maize flour incorporated and control cookies

Parameters	Control Cookies	Product (75:20:5)
Moisture Content (%)	1.59 [a] ±0.22	1.64[a]±0.1
Protein (%)	7.03[a]±0.09	8.36 [b]±0.15
Fat (%)	22.14[a]±0.49	20.59 [a]±0.81
Ash (%)	0.99 [a]±0.09	1.19 [a]±0.04
Crude Fiber (%)	0.57 [a]±0.01	1.54 [b]±0.04
Carbohydrate (%)	69.19 [a]±0.68	67.68 [a]±0.96
Calcium (mg/100g)	65.98 [a] ±0.795	69.59 [a]±0.7

*The values are the means of triplicate data. ± Figures are the standard deviation.
*Except for moisture content, all of the aforementioned statistics are in dry basis.
* Means with similar alphabets do not significantly differ from one another.

3.3.1.1 Effect in Moisture Content

Cookies made with maize flour were found to have the highest moisture level, at 1.64%, compared to control cookies, which had a moisture content of 1.59%. There was 0.04% discrepancy between two cookies. It was since maize flour also has a high moisture content, this is what caused the optimized sample's moisture content to rise. Similar to Mustafa *et al.*, (1986), reported an increase in moisture content of bakery products with increase in protein content, there was also increase in moisture content in above study. The moisture content was not changed significantly.

3.3.1.2 Effect in Protein Content

The study discovered that the optimized sample had more protein content than the control sample. The protein content of control cookies and optimized sample was 7.03% and 8.36% respectively. The difference between optimized and control sample was 1.33%. There was a significant difference in protein between control sample and optimize sample. As an emulsifying agent, egg was added in the cookies which results the increment in protein content. According to (Soni *et al.* 2018) protein level of cookies can be increased by partially replacement of refined wheat flour with potential protein rich cereals and legumes, in this case is corn flour. Since, chickpea flour is well-known form of plant-based protein because of its comparatively greater protein content and utilizing chickpeas' natural protein-richness along with maize flour which also had good amount of protein, raised overall protein content of optimized sample.

3.3.1.4 Effect in Ash Content

The above study discovered that the cookies incorporated with maize flour were found to have high ash content, at 1.19%, compared to control sample, which had fat content of 0.99%. There was 0.2% discrepancy between two cookies. The ash content of cookies increased in optimized sample. However, at 5% level of significance, the difference between the means of control sample and optimized sample was not significantly. The increase in ash content may be due to the high mineral content in the optimized sample which was similar to the study carried out by (Francischi *et al.*, 1994). Similarly, according to (Selvira *et al.*, 2020), the ash content of cookies with corn flour substitution was highest with a concentration of 20% and the result above also observes that the ash content was seen higher in optimized sample with 5% incorporation of maize flour.

3.3.1.5 Effect in Fiber Content

The above study discovered that the cookies incorporated with maize flour were found to have high fiber content, at 1.54%, compared to control sample, which had fat content of 0.57%. There was 0.97% discrepancy between two cookies. At 5% level of significance, the means of the optimized sample and the control sample did differ significantly. Since, both chickpea flour and maize flour is fibrous in nature so, its incorporation resulted in increment of fiber content. There are various types of fiber in each flour, including cellulose, hemicellulose, and pectin. The mixture of these several fiber types had raised the overall content of crude fiber. According to (Selvira *et al.*, 2020), there was also increment in crude fiber with substitution of 40% corn flour in cookies. A similar trend was observed by Suarni (2005) which states that corn flour based cookies has a higher crude fiber.

3.3.1.6 Effect in Carbohydrate

Carbohydrate content of cookies was found to be decreased in optimized sample. The cookies incorporated with maize

flour were found to have low carbohydrate, at 67.68%, compared to control sample, which had carbohydrate of 69.19%. There was 1.51% discrepancy between two cookies. At 5% level of significance there was no significant difference between control sample and optimized sample.

This result compiles with research of Noor Aziah, (2012). The similarities in between the reference and study are because of using similar proportion of ingredients i.e. 15% corn flour being incorporated with chickpea and wheat flour and also using same recipe while making cookies. All three types of flour wheat, chickpea, and maize have a fair amount of fiber. The fiber content rises when these flours are added to the optimized sample. The sample's overall carbohydrate content may have declined as a result of the increased fiber content.

3.3.1.7 Effect in Calcium Content

Calcium content of cookies was found to be increased in corn flour incorporated cookies. The optimized cookies were found to have high calcium content at 69.59 mg/100g, compared to control sample which had calcium of 65.98mg/100g. There was 3.61% discrepancy between two cookies. At 5% level of significance, there was no significant difference between the means of control sample and best sample. This result shows that the calcium content in maize flour incorporated cookies increased which might be due to high ash content in maize flour. According to (Sebečić *et al.*,2005) calcium content in different kinds of cookies/biscuit ranged from 20.43 up to 87.92 mg/100 g. So, the calcium content in above study was within the range.

3.4 Analysis of physical parameters of Control and best sample

The physical characteristics of the two types of cookies are shown in Table 4. Results of these studies indicated that there is no significant difference ($p>0.05$) in terms of weight, diameter, thickness and spread ratio of control sample and best product. Low weight was indicated in wheat: chickpea cookies at 20.36g. Diameter and Thickness of best product increased with 22.1mm and 1.5mm. The means of spread ratio of the best product was greater than the control product, however no significance difference was observed.

Table 4: Physical parameters of Control and optimized samples.

Sample	Control Cookies	Product (75:20:5)
Weight (g)	$20.36^{a}\pm0.30$	$21.87^{a}\pm0.57$
Diameter(mm)	$261^{a}\pm1$	$283.5^{a}\pm1.5$
Thickness(mm)	$36.5^{a}\pm0.5$	$38^{a}\pm1$
Spread Ratio (D/T)	$7.14^{a}\pm0.17$	$7.58^{a}\pm0.12$
Density (kg/m^3)	$10.60^{a}\pm0.97$	$9.14^{a}\pm0.15$

*Values are the means of triplicate data. ± Figures are on standard deviation.
* Means with similar alphabets do not significantly differ from one another.

Corn flour incorporated cookies have the highest diameter even though the protein content is high. Barron and Esponiza (1993) reported that addition of 15% chickpea flour or more in the corn flour mixture will decrease it viscosity. This may cause the viscosity of corn flour dough reduce and increase the spread rate. Dough with lower viscosity cause cookies to spread at faster rate (Hoseney and Roger, 1994; Hoseney *et al.*, 1988). In this formulation, 5 % corn flour was added and which might have reduced the viscosity of cookie dough furthermore increasing the spread rate even though the protein content was high. According to (Yamazaki, 1959, Hoseney *et al.*, 1988, Hoseney and Rodger, 1994; Miller, 1997) as cited in (Noor Aziah *et al.,* 2012) Cookie spread rate appears to be controlled by dough viscosity and the same event can be seen in above study.

Similarly, in the context of baking and cookies, density influences the final baked product's texture and properties. The type and quantity of ingredients used, the baking temperature, the moisture level, and the mixing procedure all have an impact on the density of cookies. A less dense cookie typically has a lighter and softer texture, whereas a thicker cookie typically has a firmer and more compact one (Jemziya & Mehendran, 2017). The above study shows that control sample had density of 10.60 kg/m^3 while the density of Sample S1 was 9.14 kg/m^3. However, there was no significant difference in between the samples. This implies that the corn flour incorporated cookies had firmer and softer texture than control sample.

4. Conclusion

Cookies are a processed food with low cost and convenient availability that delivers good taste and nutritional benefits. It is now considered to be a necessary part of a typical Nepalese household's daily diet rather than just a luxuriant tea item snack. Due to their long shelf life, cookies can be useful for feeding programs and other urgent emergency situations. Maize flour can be used to make cookies to increase their nutritional value. It is produced in various parts of the country and is known for its nutritional value. In Nepal maize is consumed in different forms. Maize flour offers versatility in Nepali cuisine, which is mostly consumed as Dindo, Makai ko roti, Satoo (incorporated with maize, gram, soyabean) and khole.

This study was mainly focused on nutritional value addition by incorporating maize flour at various levels of incorporation. Thus, formulated cookies were subjected to proximate analysis, and calcium content. The incorporation was carried out as 5%,10%,15% and 20% and the best product was found out through sensory analysis.

The cookies formulated were soft dough type. The sensory analysis was carried out based on appearance, color, taste, texture, flavor and overall acceptance. The data obtained were subjected to statistical analysis at 95% confidence level. The cookies with 5% maize flour showed good acceptability. At 95% level of confidence, it was observed that, the cookies made from different level of maize flour incorporation, 5%, 10% and 15% and 20% were significantly different from each other in different sensory attributes. In case of appearance, control sample, and S4 sample were significantly different while sample S1, S2 and S3 did not show any significant difference. Similarly, with color, control, S1 and S4 were significantly different from each other. Control, S1 and S4 showed significant difference in taste. Likewise, Control, S1, S2 and S3 showed significant difference with S4 in terms of texture. S1, S2 and S4 was significantly different as the flavor development in sample S4 was not that acceptable due to little more use of maize flour. Control, and S1 differ different significantly with S3 and S4 for overall acceptability. The overall study showed that maize flour incorporated cookies at 5% incorporation would give a nutritionally enriched product with best acceptability.

References

Ahmad, F., "Chickpea (*Cicer arietinum L.*)," *Genetic Resources, Chromosome Engineering, and Crop Improvement – Grain Legumes*, Vol. 1, pp. 187-217, 2005.

Aini, N., Sustriawan, B., Wahyuningsih, N. and Mela, E., "Blood Sugar, Haemoglobin and Malondialdehyde Levels in Diabetic White Rats Fed a Diet of Corn Flour Cookies," *Foods*, Vol. 11, No. 12, Article 1819, 2022.

Akpapunam, M. and Darbe, J., "Chemical Composition and Functional Properties of Blends of Maize and Bambara Groundnut Flours for Cookie Production," *Plant Foods for Human Nutrition*, Vol. 46, pp. 147-155, 1994.

AOAC, *Official Methods of Analysis*, 12th ed., Association of Official Analytical Chemists, Washington, D.C., 2005.

DFTQC, *Nepalese Food Composition Table 2017*, Government of Nepal, Ministry of Agricultural Development, Babarmahal, Kathmandu, Nepal, 2017.

Dongmo, H., Tambo, S. T., Teboukeu, G. B., Mboukap, A. N., Fotso, B. S., Djuidje, M. C. T. and Klang, J. M., "Effect of Process and Variety on Physico-Chemical and Rheological Properties of Two Corn Flour Varieties (ATP and Kassaï)," *Journal of Agriculture and Food Research*, Vol. 2, Article 100075, 2020.

Francischi, D., Salgado, J. M. and Leitao, R. F. E., "Chemical, Nutritional and Technological Characteristics of Buckwheat and Non-Prolamine Buckwheat Flours in Comparison with Wheat Flour," *Plant Foods for Human Nutrition*, Vol. 46, pp. 323-329, 1994.

Hoojjat, P. and Zabik, M., "Sugar-Snap Cookies Prepared with Wheat-Navy Bean-Sesame Seed Flour Blends," *Cereal Chemistry*, Vol. 61, No. 1, pp. 41-44, 1984.

Hoseney, R. C. and Rogers, D. E., "Mechanism of Sugar Functionality in Cookies," in Faridi, H. (Ed.), *The Science of Cookie and Cracker Production*, pp. 203-226, Avi Publishing, New York, 1994.

Hoseney, R. C., Wade, P. and Finley, J. W., "Soft Wheat Products," in Pomeranz, Y. (Ed.), *Wheat Chemistry and Technology*, pp. 407-456, American Association of Cereal Chemists, St. Paul, MN, 1988.

Hunaefi, D., et al., "Optimizing the Tray Dryer Temperature and Time of White Corn Flour Culture," *Food Research*, Vol. 5, No. 5, pp. 95-104, 2021.

Igbabul, B. D., et al., "Physicochemical and Sensory Properties of Cookies Produced from Composite Flours of Wheat, Cocoyam and African Yam Beans," *Journal of Food Research*, Vol. 4, No. 2, pp. 150, 2015.

Ikuomola, D., et al., "Quality Assessment of Cookies Produced from Wheat Flour and Malted Barley (*Hordeum vulgare*) Bran Blends," *Cogent Food & Agriculture*, Vol. 3, No. 1, Article 1293471, 2017.

Jemziya, M. B. F. and Mehendran, T., "Physical Quality Characters of Cookies Produced from Composite Blends of Wheat and Sweet Potato Flour," 2017.

Jukanti, A. K., "Nutritional Quality and Health Benefits of Chickpea (*Cicer arietinum L.*): A Review," *British Journal of Nutrition*, Vol. 108, Suppl. 1, pp. S11-S26, 2012.

Kishorgoliya, N., et al., "Nutritional Quality of the Developed Multigrain Flour and Cookies," *Journal of Pharmacognosy and Phytochemistry*, Vol. 7, No. 1S, pp. 2886-2888, 2018.

Miller, R. A., Hoseney, R. C. and Morris, C. F., "Effect of Formula Water Content on the Spread of Sugar-Snap Cookies," *Cereal Chemistry*, Vol. 74, No. 5, pp. 669-671, 1997.

Mishra, V., "Development and Compositional Analysis of Protein Rich Soybean-Maize Flour Blended Cookies," *Journal of Food Processing and Technology*, Vol. 3, No. 9, pp. 1-5, 2012.

Mustafa, A. I., Alwessali, M. S., Al-Busha, O. M. and Amia, R. H., "Utilization of Cowpea Flour and Protein Isolate in Bakery Products," *Cereal Foods World*, Vol. 31, pp. 756-759, 1986.

Noor Aziah, A., et al., "Physicochemical and Organoleptic Properties of Cookies Incorporated with Legume Flour," 2012.

Oladapo, A. S., Adepeju, A. B., Akinyele, A. A. and Adepeju, D. M., "The Proximate, Functional and Anti-Nutritional Properties of Three Selected Varieties of Maize (Yellow, White and Pop Corn) Flour," *International Journal of Scientific Engineering and Science*, Vol. 1, No. 2, pp. 23-26, 2017.

Ortíz-Fernández, M. P., et al., "Digestibility and Acceptability of Wheat Flour Cookies Partially Substituted with High Amylose Maize Starch," *Plant Foods for Human Nutrition*, Vol. 74, pp. 446-447, 2019.

Ranganna, S., *Handbook of Analysis and Quality Control for Fruit and Vegetable Products*, 2nd ed., Tata McGraw Hill Education Private Limited, New Delhi, 2014.

Selvira, J., Rahmawati, R., Maulani, R., Hunaefi, D. and Saputra, D., "The Effect of Fermented White Corn Flour and Wheat Flour Formulation on the Quality of Cookies," *Proceedings of the Food Ingredient Asia Conference (FiAC)*, 2020, https://doi.org/10.5220/0010513800003108.

Šebečić, B. and Dragojević, I. V., "Biscuits as a Source of Calcium, Magnesium, Sodium and Potassium in Nutrition," *Deutsche Lebensmittel-Rundschau: Zeitschrift für Lebensmittelkunde und Lebensmittelrecht*, Vol. 101, pp. 392-397, 2005.

Soni, N., "Studies on Development of High Protein Cookies," *International Journal of Chemical Studies*, Vol. 6, pp. 439-444, 2018.

Suarni, "Development of Corn Flour Based Pastry Products in the Framework of Supporting Agroindustries," *Proceedings of the National Seminar of the Indonesian Agricultural Engineering Association*, Faculty of Agricultural Technology, Padjadjaran University, LIPI, Bandung, 2005.

Ubbor, S., et al., "Physiochemical and Sensory Evaluation of Cookies Produced from Composite Flours of Wheat, Bambara Nut and Orange Fleshed Sweet Potato," *Journal of Agriculture and Food Sciences*, Vol. 20, No. 1, pp. 60-77, 2022.

Yamazaki, W. T., "The Application of Heat in the Testing of Flours for Cookie Quality," *Cereal Chemistry*, Vol. 36, pp. 59-69, 1959.

Zoulias, E. I., Oreopoulou, V. and Tzia, C., "Effect of Fat Mimetics on Physical, Textural and Sensory Properties of Cookies," *International Journal of Food Properties*, Vol. 3, No. 3, pp. 385-397, 2000.