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Original Paper

The Preparation and Quality Evaluation of Biscuit Using Composite Flour by Mixing Wheat Flour, Chickpea Flour, and Peanut Flour

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***Abstract*— The main aim of this study was to determine the best formulation of biscuit using roasted gram flour and roasted peanut flour with wheat flour. Bengal gram flour, peanut flour, and wheat flour were blended in the following ratios: sample A; 2.5:2.5:95, sample B; 5:5:90, sample C; 7.5:7.5:85, sample D; 10:10:80. Initial analysis showed that 7.5% roasted gram flour, 7.5% roasted peanut flour and 85% wheat flour can be blended to prepare quality biscuit. The protein content of biscuit ranged from 6.78% in wheat flour biscuit to 13.67% in composite flour biscuit. Fat (16.63%), crude fiber (1.96%), protein (13.67%), and ash content (2.805%) of composite flour biscuit was higher than that of wheat flour biscuit. The shelf life of the composite flour biscuit was studied for 90 days at 15-day interval. The initial and final values of acid value, peroxide value, and moisture were found to be 0.13 mg KOH/gm, 0.265 mg KOH/gm, 0.86 meq peroxide/kg fat, 1.904 meq peroxide/kg fat, and 4%, 5.1%, respectively.**

Keywords*— biscuit, milk powder, composite flour, proximate composition, sensory evaluation, shelf life

I. INTRODUCTION

'Biscuits' is the original British word used to include small baked products (usually of flat shape) based on wheat flour with various inclusions of fat, sugar, and other ingredients. It therefore includes crackers and the more luxurious products called cookies. They all have low moisture content and, if packed to protect them from atmospheric moisture, will have a long shelf life. Americans are also specific with the terms 'crackers' and 'cookies', and they do not have a generic word to cover all these types of baked products [10]. Biscuit is a good source of nutrients because it contains carbohydrates, fats, proteins, minerals, and vitamins. Carbohydrate and fats provide heat and energy to the body. The proteins are materials for growth and repair of tissues, whilst minerals provide materials for bone growth and repair. Equally important is that vitamins are associated with regulation of body processes and maintaining normal vitality.

Bengal Gram also known as Chickpea (*Cicerarietinum L.*) is a major grain legume cultivated for its edible seeds in the Mediterranean Basin, Asia, and Australia. The plant is quick-growing and branched, and it reaches a height between 20 and 60 cm, even up to 1 m. It has a deep taproot, down to 2 m and many lateral secondary roots exploring the upper layers (15-30 cm) of the soil. The stems are hairy, simple or branched, straight or bent. Leaves are 5 cm long with 10 to 20 sessile, ovate to elliptical leaflets. Chickpea flowers are white, pink to purplish or blue, typically papillonaceous, and solitary. The pod is pubescent, inflated, and oblong, with 2 or 3 seeds. The seeds vary in size (5 to 10 mm in diameter), shape (spherical to angular) and color (creamy-white to black) [5][8][18]. Chickpea is a multipurpose grain legume widely used around the world, notably as the source of protein [5].

Peanut is a legume which is widely grown as a food crop. It is a herbaceous plant with different varieties, such as Boro light, Boro Red, Mokwa, Campala, Guta, and Ela [1]. Groundnut is an inexpensive source of high quality dietary protein and oil [21]. The vast food preparations incorporating groundnut to improve the protein level has aided in reducing malnutrition in the developing Countries [3].

This generation has been more health conscious. The population are getting their protein intake high through the means of protein supplement. We can develop food products rich in protein through product diversification which can take place as an alternative to the protein supplement in diet. Biscuit is famous among all age groups of people as a snacks and can be an easy target to get the research going due to its fondness among the people. This study is based on preparation of high protein biscuit.

II. MATERIALS AND METHODS

A. Materials

Chickpea or Bengal gram, peanut, wheat flour, fat, sugar, salt, and skimmed milk powder were obtained from local market of Dharan (26.8065° N, 87.2846° E).

B. Methods

Methods of flour preparation

Chickpea flour

Flour was prepared as shown in Fig 1.

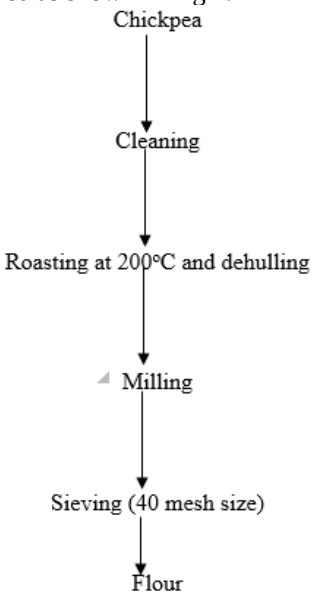

Fig. 1 Flowchart for the preparation of chickpea flour

Peanut flour

Similar process was followed as shown in Figure 1. Peanut was taken instead of chickpea.

Preparation of flour blends

Different combinations of wheat flour, Chickpea flour, and Peanut flour were prepared as shown in Table 1.

Table 1. Preparation of flour blends

Sample	Wheat flour (g)	Chickpea flour (g)	Peanut flour (g)
R	100	0	0
A	95	2.5	2.5
B	90	5	5
C	85	7.5	7.5
D	80	10	10

Preparation of biscuits

Biscuit was prepared using the creaming method at Gorkha Bakery of Itahari, Nepal as described by [11]. The ingredients used are presented as in Table 2. The preparation process is shown in Figure 2.

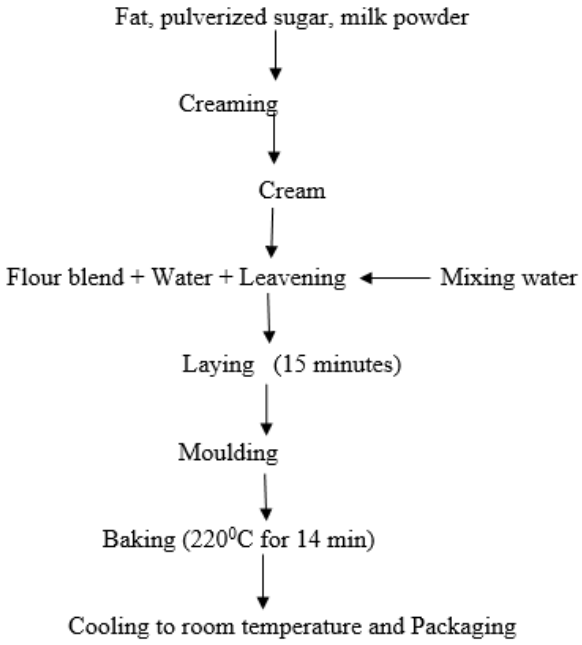

Fig. 2 Flowchart for the preparation of biscuit

Table 2. Ingredients

Ingredients	Amount (g)
Flour blends	100
Sugar	30
Shortening	20
Salt	1
Sodium bicarbonate	0.5
Ammonium bicarbonate	1
Water	20
Skimmed milk powder	2
Syrup	5

Wheat flour, chickpea flour, and peanut flour were blended in the above proportion. The dough was sheeted and framed. The sheeted dough was molded using a molder. The cut dough was transferred to the aluminum tray. The biscuits were then baked in an electric oven maintained at 220°C for 14 minutes. The baked biscuits were allowed to cool for about 30 minutes and were packed into bags for further analysis.

Analysis

Physiochemical analysis of flour

Gluten content

Gluten content was determined by hand washing (working dough in water to release starch and soluble proteins) as described in [14].

$$Gluten\ content\ \% = \frac{wt.of\ gluten}{Wt.of\ sample\ taken}\ x\ 100$$

Moisture content

The moisture of wheat flour, chickpea flour, and peanut flour was determined by using hot air oven as per described by [15].

$$Moisture\ content\ \% = \frac{Initial\ wt. - final\ wt.}{Wt.of\ sample\ taken}\ x\ 100$$

Total ash

Total ash was determined as described by [15].

$$\%\ Total\ ash = \frac{wt.of\ ash}{Wt.of\ sample\ taken}\ x\ 100$$

Crude fat

Crude fat in wheat, chickpea, and peanut flour was determined by Soxhlet extraction method as per described by [15].

$$\%\ Crude\ fat = \frac{wt.of\ ether\ soluble\ material}{Wt.of\ sample\ taken}\ x\ 100$$

Crude protein

Crude protein was determined by macro-Kjeldhal method as described by [15].

$$Nitrogen\ (\%) = \frac{(Sample\ titre - Blank\ titre)\ ml \times\ N\ of\ HCl \times 14 \times 100 \times 100}{Aliquot\ (ml)\ \times\ Wt.of\ sample\ (g)\ \times\ 1000}\ x\ 100$$

$$Protein\ (\%) = Nitrogen\ \% \times 6.25$$

Crude fiber

Crude fiber in wheat, chickpea, and peanut flour was determined by method described in [15].

$$\%\ Crude\ fiber = \frac{loss\ in\ weight\ noted}{Wt.of\ sample\ taken}\ x\ 100$$

Carbohydrate

Total carbohydrate content was determined by difference method as described in [15].

$$Total\ carbohydrate(\%) = 100 - (moisture + protein + fat + crude\ fiber + ash)\ \%$$

Physiochemical analysis of biscuits

Moisture, crude fat, crude fiber, crude protein, total ash, and total carbohydrate of biscuits were determined by the same

Diameter of biscuits

The diameter of biscuit was measured by laying three biscuits edge to edge with the help of a scale rotating them 90^o and measuring the diameter of three biscuits (cm) and then taking average value [4].

Thickness of biscuits

Thickness was measured by stacking three biscuits on top of each other and measuring average thickness [4].

Sensory evaluation

The sensory evaluation for overall quality was carried out with 10 semi- trained panelists. The parameters for sensory evaluation were color, flavor, crispiness, texture, and overall acceptability. Sensory evaluation was performed by hedonic rating test as described by [15][20].

Statistical analysis

All of the data obtained in this research work was analyzed by the statistical program Genstatwhich developed by Lawes Agricultural Trust (1995). The statistical analysis also included ANOVA (at 5% level of significance). LSD and interaction effects were obtained to determine whether the sample was significantly different from each other and to find out also which one was superior among them [19].

III. RESULTS AND DISCUSSION

A. Proximate composition of raw materials

The proximate compositions of wheat flour, peanut flour, and chickpea flour were analyzed. The proximate composition is presented in Table 3.

Table 3. Proximate composition of wheat flour, peanut flour and chickpea flour

Parameter	Wheat flour (%)	Peanut flour (%)	Chickpea flour (%)
Moisture	12.55(0.15)	3.2(0.165)	10.7(0.26)
Crude protein	9.7(0.165)	27(0.33)	22.5(1.58)
Crude fat	1.5(0.14)	38.39(1.20)	6.2(0.21)
Crude fiber	0.42(0.03)	0.195(0.0065)	1(0.12)
Total ash	0.51(0.026)	2.42(0.65)	2.5(0.13)
Carbohydrate	75.35(0.76)	30.79(0.43)	58.1(1.8)
Gluten content	9.08(0.061)	0	0

The crude protein, moisture, crude fat, crude fiber, and total ash content of the wheat flour found from the analysis are shown in the Table 3. These values fall in the range of flour as described [2]. The gluten of wheat flour was found to be 9.08 % on dry basis, while in case of peanut and chickpea flour, gluten content was not observed. The peanut flour and chickpea flour was prepared as described in the Material and Method, and it was analyzed for its proximate composition. The obtained values are shown in Table 4. The protein content of wheat flour was found to be 9.7 %, while it was observed to be 27% in peanut flour and 22.5% in chickpea flour. In addition, fat content of all the constituent flour was observed. The fat in wheat flour, peanut four, and chickpea flour was 1.5%, 38.39 %, and 6.2 % respectively.

B. *Result of incorporation of composite flour in sensory quality of biscuit*

The samples were presented to 10 semi-trained panelists. The panelists were suggested to evaluate the samples using the score sheets for different attributes. All the scores were summed up, and the best product was found out by statistical analysis. The result was shown in Figure 3. The similar alphabet above the error bar indicates that the samples are not significantly different ($p < 0.05$), and the error bar represents the standard deviation. The ANOVA at 95% level of confidence ($p < 0.05$) showed that the samples A, B, C and D were significantly

different from each other with regard to the overall acceptability.

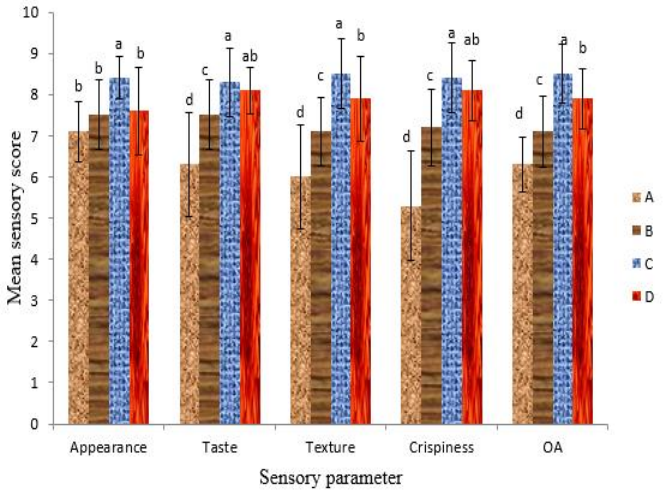

Fig 3. Mean sensory scores of different samples of composite flour biscuit

Appearance

The ANOVA results showed that A had no significant difference from B and D ($p < 0.05$). The peanut enrichment in biscuits had significant effect in color. C had the highest sensory score. The darker colour of D may be due to Maillard reaction from reducing sugar and protein [7]. In this case, an increase in protein content, especially the higher lysine, from peanut and chickpea flour probably caused the darker crust color [6].

Taste

A and B, A and C, A and D, B and C, B and D showed significant difference from each other, whereas C and D showed no significant difference from each other ($p < 0.05$). C had the highest mean value, and A had the least mean value. This change in taste may be due to combined effect of Maillard reaction from reducing sugar and protein [7].

Texture

The texture of C was best of all samples. Sample D showed cracks on the upper crust which might be due to the least gluten development. In addition, this is also associated with higher amount of peanut flour and chickpea flour with less gluten used. Sample C showed firm texture and no cracks, which might be due to adequate amount of gluten development.

Crispiness

The use of excessive non-glutinous flour reduces the textural strength of the biscuit and leads to increase in crispiness, which causes greater acceptability due to slight cohesive nature rather than being too elastic as described by [16]. Sample C received higher acceptability with regard to crispiness, particularly due to adequate amount of peanut flour and chickpea flour.

Overall acceptability

Sample C was significantly different from other samples and had the highest sensory score. The overall acceptability mean marked C as superior over the other samples.

C. The Proximate analysis of composite flour biscuit and normal wheat biscuit

The proximate analysis of sample C and normal wheat flour biscuit was carried out. The result is displayed in Table 4.

Table 4. Proximate analysis of Composite flour biscuit and Wheat biscuit.

Parameters in %	Composite flour biscuit*	Wheat biscuit*
Moisture	4 (0.26)	1.89 (0.56)
Fat	16.63 (0.71)	7.11 (0.78)
Protein	13.67 (0.38)	6.92 (0.89)
Crude fiber	1.56 (0.04)	0.65 (0.56)
Ash	2.805 (0.29)	1.20 (0.08)
Carbohydrate	61.34 (1.21)	71.03 (0.44)
Energy (Kcal/100g)	449.71(3.07)	375.79 (0.66)

*The values are the means of triplicate samples and the values in the parenthesis are standard deviation.

The ash content of biscuit was increased in composite biscuit. The increase in ash content may be due to the high mineral content in the chickpea and peanut i.e., iron, copper, and magnesium [9]. The moisture ranged from 1.89% in wheat biscuit to 4% in composite biscuit. The increase in moisture content may be due to the increase in protein content. [13] reported an increase in moisture content of bakery products with increase in protein content. The fat content of composite flour biscuit was higher than that of wheat flour biscuits. No definite increase or decrease in crude fiber contents was observed. The protein content of biscuits ranged from 13.67% in composite biscuit to 6.92% in wheat biscuit. The biscuit showed an increase in protein content when composite flour concentration was increased which might be due to the use of chickpea flour and peanut flour.

D. Shelf-life evaluation of the composite flour biscuit

The shelf life of the composite flour biscuit was studied for 3 months with triplicate samples. The product was packed in polypropylene bags and stored in cool and dry place. The acid value and peroxide value of extracted fat and the moisture content of the product were evaluated from the date of manufacture for 3 months. The result of analysis is shown in Figure. 4.

The acid value of the product was initially observed to be 0.13 which reached 0.265 mg KOH/gm oil in 90 days as shown in Figure 4. A significant difference in the acid value of the extracted fat was observed throughout different analysis intervals of 0 day, 15 days, 30 days, 45 days, 60 days, 75 days, and 90 days, but the acid value was below the unacceptability level of 0.3 mg KOH/gm oil [12]. The increase in acid value shows a gradual increase which suggests that it will be self-preserved until 6 months as described by [17].

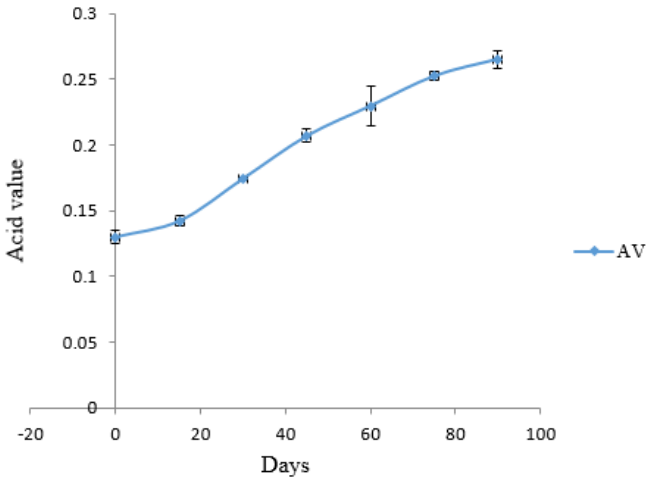

Fig 4. Acid value of the product

The peroxide value of the product was initially observed to be 0.86 which reached 1.904 within 90 days. A significant difference in the peroxide value of the extracted fat was observed after 0 day, 15 days, 30 days, 45 days, 60 days, 75 days, and 90 days, but the peroxide value was far below the unacceptability level of 3 meq peroxide/kg fat [12]. The peroxide value of the product is shown in Figure 5.

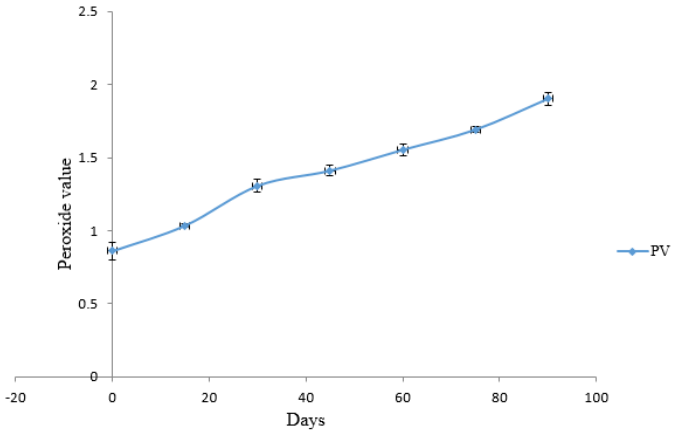

Fig. 5 Peroxide value of the product

The moisture of the product was initially observed to be 4% which reached 5.098% within 90 days as given in Figure 6. A significant difference in the product moisture was observed after 0 day, 15 day, 30 days, 45 days, 60 days, 75 days, and 90 days, but the moisture was below the unacceptability level of maximum 6% [12]. Hence, the biscuit was proven safe for consumption before expiration.

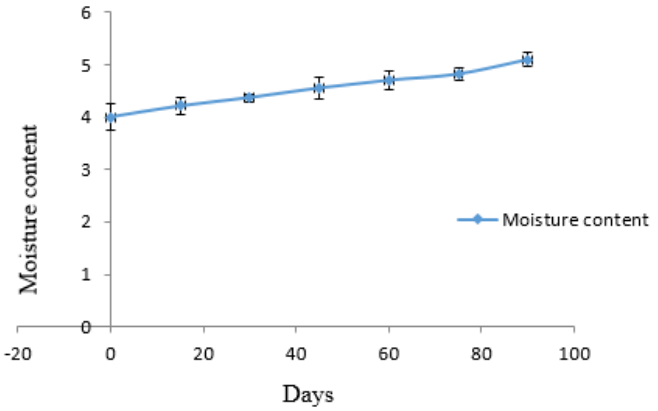

Fig. 6 Moisture content of the product

Hence, the shelf life of the product was evaluated and all the parameters determining the shelf stability of biscuit were found to be within the standard limit. The increase in acid value, peroxide value, and moisture signified that the product would be safe for consumption until standard best before time of 6 months. Packaging in laminated packets would have further increased the biscuit stability.

The increase in the acid value, peroxide value, moisture, and the projected shelf life

The probable shelf life of the biscuit was projected by studying the increase of the values. The increase in the acid value was calculated to be 0.0015 mg KOH/gm oil per day. This rate in the acid value will take 200 days to cross the unacceptable value of AV which is 0.3 mh KOH/gm oil per day. Similarly, the increase of peroxide value was calculated to be 0.0116 meqv peroxide/kg fat per day. This rate in the peroxide value will take 258 days to cross the unacceptable value of PV which is 3meq peroxide/kg fat.

The moisture was observed to be increasing with a rate of 0.0122% per day. This rate in the moisture content will take 491 days to cross the unacceptable value of moisture which is 6%. The shelf life of the biscuit was calculated to be higher than the normal 6 months shelf life of biscuit as observed by [17].

IV. CONCLUSION

Composite biscuit prepared by using wheat flour, peanut flour, and chickpea flour in the ratio 85:7.5:7.5 was found to be the best in terms of sensory analysis with no adverse effect on the acceptable quality. Incorporation of peanut flour and chickpea flour above the ration of 10:10 shows an adverse effect on the textural quality and good body formation. The shelf life of the composite flour biscuit is found to be satisfactory up to 3 months. The energy value of biscuit is found to be 449.71 Kcal per 100 grams of biscuit. The prepared biscuit is high in protein and can be introduced as the alternative of protein supplements in diet.

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