



## Effect of Incorporation of Oats and Malted Barley Flours on the Quality of Cookies

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### Abstract

The study aimed to determine the potential of oats and malted barley flours incorporation on cookie making. D-optimal mixture design was employed for formulating the recipe of cookies. Seven different formulations of recipe containing oats flour: malted barley flour: wheat flour in the ratio of 20:25:55, 15:30:55, 13:32:55, 10:35:55, 7:38:55, 5:40:55 and 100:0:0 was prepared. The prepared cookies were subjected to sensory evaluation for consumer acceptability and the data obtained were statistically analyzed using two-way ANOVA (no blocking) at a 5% level of significance. From the mean sensory scores, the formulation 10:35:55 was selected as the optimized formulation and subjected to proximate analysis. The optimized cookies were significantly ( $p < 0.05$ ) superior in the case of protein (7.50%), fat (22.93%), fiber (2.90%), and ash content (0.97%) to wheat cookies (6.43%, 18.83% 0.83% and 0.41% respectively) as seen higher in oats and malted barley flours than wheat flour. The calcium content was found to be significantly ( $p < 0.05$ ) higher in optimized cookies (35.3 mg/100g) than wheat cookies (18.40 mg/100g).

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### 1. Introduction

A small, flat, sweet, baked good is a cookie that contains flour, sugar, eggs, and either butter, cooking oil, or another fat or oil, as well as other ingredients like raisins, oats, chocolate chips, or nuts (Loza et al., 2017). The cookie appears to be larger with a smoother chewier texture compared to a biscuit (Chinma & Gernah, 2007). Cookies are ready-to-eat and cost-effective food products having longer shelf life (Alka et al., 2017; Al-Marazeeq & Angor, 2017). The refined flour contains higher starch and lower dietary fiber and minerals content, resulting in low protein, fat, and mineral content in cookies (Chappalwar et al., 2013). Hence, it is essential to replace refined flour with other blends for the improvement of the nutritional quality of cookies (Ishimoto et al., 2007; Singh, 2020). The nutritive value and textural qualities of cookies are being improved by modifying their nutritive composition (Zadeike et al., 2018; Li et al., 2020). Such effects are very often achieved by increasing the ratio of whole-grain-raw materials (Apotiola, 2013).

Oats have been recognized as a healthful and nutritious cereal containing a high concentration of soluble fiber (Zhao et al., 2014). Oats have also been linked to the health claims attributed to the use of  $\beta$ -glucans, and are valuable sources of antioxidant vitamin E (tocopherol), phytic acid, and phenolic acid (Ahmed et al., 2014). Malted barley is a highly nutritious food but is rarely used in making baked products. The use of malted barley increases bio-functional substances and improves organoleptic qualities due to softening of texture and increase of flavor in grains which leads to particular flavor given to the derived products (Arif et al., 2014). During the malting process, hydrolytic enzyme production and/or release is maximized leading to cell-wall degradation and protein solubilization with a minimal starch breakdown (Hornsey, 2013). For this to occur, malting aims to both accelerate germination and retard embryo growth, essentially conflicting activities (MacLeod & Evans, 2016).  $\beta$ -glucans from barley have also been regarded as important functional ingredients for the

cereal foods industry (Sharma, 2015).  $\beta$ -glucan, a soluble dietary fiber rich in oats and barley, reduces blood cholesterol levels and the risk of heart-related diseases (Malkki & Virtanen, 2001). The US Food and Drug Administration allows a health claim to be made on food labels containing 0.75 g of  $\beta$ -glucan per serving (FDA, 1997). Malting converts the physical structure of the barley grain and allows synthesis or activation of a series of enzymes such that the final product (malt) is more readily used in the subsequent stages of brewing, distilling, or food manufacture (MacLeod & Evans, 2016).

Cookies prepared from refined wheat flour are nutritionally poor, which is deficient in vitamins, minerals, and dietary fiber (Asifulalam et al., 2014). Composite flour technology has been widely adopted around the globe for the development of functional foods (Bhaduri, 2013). Various types of composite flours have been successfully used in the preparation of bread, pasta, and cookies (Zouari et al., 2016). The flour blends with high dietary fiber flour are widely used in the bakery industries to increase the consumer dietary fiber intake (Ho et al., 2017). Composite flours are advantageous because the inherent deficiencies of essential amino acids in wheat flour (lysine, tryptophan, and threonine) are supplemented from other sources (Ikuomola et al., 2017). With the incorporation of oats and malted barley flour to the wheat flour, the addition of dietary fiber as well as soluble proteins may be seen in the final product. Therefore, the objective of this research work is to prepare cookies using oats, malted barley, and wheat flour; and to perform sensory as well as physicochemical analysis of the cookies.

**Table 1:** Recipe formulation for cookies.

Ingredients	A	B	C	D	E	F	G
Wheat flour	55	55	55	55	55	55	100
Oats flour	20	15	13	10	7	5	0
Malted barley flour	25	30	32	35	38	40	0
Sugar	47.2	47.2	47.2	47.2	47.2	47.2	47.2
Fat	55.5	55.5	55.5	55.5	55.5	55.5	55.5
Baking powder	1.9	1.9	1.9	1.9	1.9	1.9	1.9
Salt	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Egg yolk	18	18	18	18	18	18	18

## 2. Materials and Method

### 2.1 Materials

Oats flakes named 'D'Lite' manufactured by D'Lite Food Packaging Industries, Kathmandu were brought from the local store of Dharan. A locally available variety of barley (*Hordeum vulgare*) namely *galt* was collected from the local market of Dharan. Wheat flour named 'Fortune maida' produced by Nutri Food Pvt. Ltd., Sonapur; sugar in the form of pulverized sugar; vegetable ghee named 'Delicious Fat Spread' manufactured by Kaira District Cooperative milk producer's Union Ltd. Anand, India; baking powder named as 'Weikfield baking powder double action' manufactured and packed by Weikfield food Pvt. Ltd., Pune, India; and eggs were collected from the local market of Dharan. The major glassware and equipment used were burette, conical flask, measuring cylinder, microprocessor flame photometer, cabinet dryer, hot air oven, Soxhlet assembly, muffle furnace, and Kjeldahl digestion and distillation set.

### 2.2 Methods

#### 2.2.1 Formulation of recipe

Design Expert (Version 12) software was used to create the recipe, and the D-optimal mixture design was used to formulate the recipe. The recipe formulation for cookies was carried out as given in Table 1. In this study, seven different formulations of cookies with variations in wheat, oats, and malted barley flour were prepared and named as A, B, C, D, E, F, and G. The amount of sugar, fat, baking powder, salt and egg yolk used in every formulation was 47.2, 55.5, 1.9, 0.55 and 18 parts respectively (Ishimoto et al., 2007).

### 2.2.2 Malting of Barley

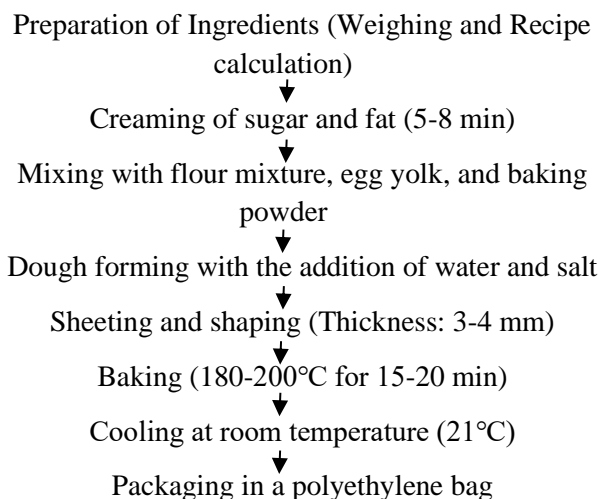
The cleaned barley grains were immersed in water to increase the moisture content up to 42-46% and left for 24 hours with a change of steeping water every 6 hours. The water was then drained with the help of a muslin cloth and spread in a tray as a thick bed of 2 cm. The grains were left for 48 hours for germination at room temperature (20-30°C) with frequently sprinkling water droplets over the bed. The germinated grains were subjected to three stages of drying; in the first stage drying to 50-60°C till 25% moisture was obtained, in second stage temperature slowly increased to 70°C till 12% moisture was obtained and in the third stage malt was dried at 71-90°C till the moisture dropped to 4-5% (Hornsey 2013).

### 2.2.3 Preparation of flour

The malted barley and oats flakes were separately cleaned, and the malted barley grains were milled in a hammer mill to obtain a fine powder while the oats flakes were ground in a mixer grinder (Havells Maxx Grind 750 Watt).

### 2.2.4 Preparation of cookies

Fat and sugar powder was first creamed. Salt was dissolved in water and added to the prepared cream mixture. As the creaming process continued; wheat flour, oats flour, malted barley flour, and baking powder were added and mixed well together. The flowchart of the overall production of cookies is given in Figure 1.



**Figure 1:** Outline of cookies production (Loza et al., 2017).

### 2.2.5 Analysis of raw materials and cookies

#### 2.2.5.1 Physicochemical Analysis

**Moisture content:** The moisture content of the samples was determined by heating in an oven at  $100 \pm 5^\circ\text{C}$  to get constant weight (Ranganna, 1986).

**Crude fat:** Crude fat content of the samples was determined by solvent extraction method using Soxhlet apparatus and solvent petroleum ether (Ranganna, 1986).

**Crude protein:** Crude protein content of the samples was determined indirectly by measuring total nitrogen content by the micro Kjeldahl method. Factor 6.25 was used to convert the nitrogen content to crude protein (Ranganna, 1986).

**Crude fiber:** Crude fiber content of the samples was determined by the method given by Ranganna (1986).

**Total ash:** Total ash content of the samples was determined by following the method given by Ranganna (1986) using a muffle furnace.

**Carbohydrate:** The carbohydrate content of the samples was determined by the difference method given by Ranganna (1986).

**Iron:** Iron content in the cookies was determined by the colorimetric method as per the AOAC method (Horeitz and Latimer, 2005).

**Calcium:** Calcium content in the cookies was determined by the volumetric method as per the AOAC method (Horeitz and Latimer, 2005).

#### 2.2.5.2 Sensory evaluation

The sensory evaluation for the overall quality of the cookies was carried out by ten semi-trained panelists. The panelists were screened initially based on their sensitivity to recognize the basic tastes. A training session was conducted to define the sensory terminologies. The test samples were served as descriptive stimuli for language development and the sensory descriptors for appearance, taste, texture, crispiness, and overall acceptability were developed. The samples were then presented to the panelists in a random order provided with a glass of water for rinsing purposes. The sensory evaluation was done in a well-lit and properly ventilated laboratory, and the panelists evaluated each sample for every attribute according to the 9-point hedonic scale (Ranganna, 1986).

### 2.2.5.3 Statistical analysis

The obtained data were analyzed by using IBM SPSS Statistics (Version 26) predictive analytics software, for Analysis of Variance (ANOVA) at a 5% level of significance. Shapiro-Wilk's test for normality and Levene's test for homogeneity of variance was performed. The data obtained from proximate analysis and sensory evaluation were subjected to one-way and two-way ANOVA respectively. Means were separated whether they are significant or not by using Tukey's honestly significant difference (HSD) method.

## 3. Results and Discussion

This work was carried out for the preparation of cookies with varying proportions of oats, malted barley, and wheat flour. The seven different formulations of cookies namely A, B, C, D, E, F, and G were prepared and their sensory evaluation was performed. Optimized formulation was chosen based

**Table 2:** Proximate composition of wheat flour, oats flour, and malted barley flour

Parameters (% db)	Wheat flour	Oats flour	Malted Barley flour
Crude protein	9.17 <sup>a</sup> ±0.15	11.94 <sup>b</sup> ±0.05	11.4 <sup>b</sup> ±0.24
Crude fat	1.07 <sup>a</sup> ±0.06	8.3 <sup>b</sup> ±0.10	1.35 <sup>a</sup> ±0.22
Crude fiber	0.45 <sup>a</sup> ±0.01	1.04 <sup>b</sup> ±0.01	4.10 <sup>c</sup> ±0.43
Total ash	0.44 <sup>a</sup> ±0.03	1.6 <sup>b</sup> ±0.01	1.17 <sup>ab</sup> ±0.12
Carbohydrate	88.87 <sup>b</sup> ±0.07	77.12 <sup>a</sup> ±0.27	81.98 <sup>ab</sup> ±1.21

\*Values are the means ± standard deviation of the triplicates. Means in a single parameter with different alphabets are significantly different ( $p < 0.05$ ).

The ash content in oats flour and malted barley flour is almost four times that in wheat flour and similar quantities of ash content in oats flour and malted barley flour were reported by Bhaduri (2013) and Arif et al. (2014) respectively. Higher ash content indicates higher mineral contents which will help in enriching the nutritional quality of cookies.

### 3.2 Sensory evaluation

Sensory evaluation was performed with the aid of different panelists evaluating the texture, crispiness, color, taste, flavor, and overall acceptability of the sample cookies. The sensory scores (9-point hedonic scale) are graphically represented in Figure 2.

Statistical analysis showed that the partial

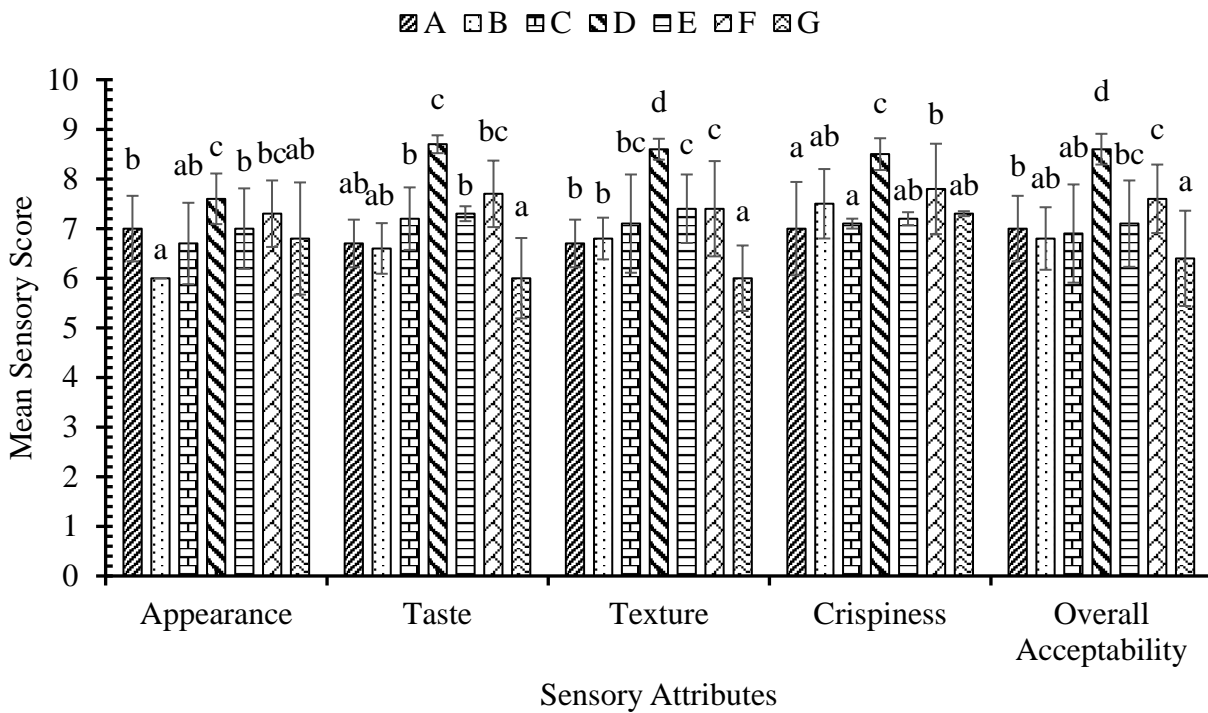
on statistical sensory evaluation. The optimized cookies and control cookies were then compared through chemical analysis.

### 3.1 Proximate composition of wheat flour, oats flour, and malted barley flour

The proximate composition of wheat flour, oats flour, and malted barley flour was determined as presented in Table 2.

Fat content in wheat flour and malted barley flour was found to be 1.35% and 1.05% which are similar as per the reports of Arif et al. (2014) respectively. However, the fat content of oats flour is 8.3% which is quite higher than that reported by Zhao et al. (2014). The fiber content in malted barley flour is 4.1% which is significantly ( $p < 0.05$ ) higher in comparison to wheat flour and oats flour. A similar amount of fiber content in malted barley flour is also reported by Arif et al. (2014).

substitution of wheat flour with oats and malted barley flours had a significant effect ( $p < 0.05$ ) on the sensory attributes of cookies. The mean sensory score for the appearance of sample D was found the highest of all other formulations which were significantly different ( $p < 0.05$ ) from other samples. This may be due to the appropriate amount of malted barley flour and oats flour, which was golden brown. This result is per Al-Marazeeq & Angor (2017) who found that the color of the fortified biscuits attained darker color after supplementation. The probable cause of the highest score for the texture of sample D may be due to the amount of fiber present in the formulation. The result is following Li et al. (2020) who found a similar result with the addition of fiber.



**Figure 2:** Graphical view of mean sensory scores of cookies

*\*Bars with similar alphabets at the top are not significantly different.*

The texture is an important factor in comparing the biscuit as it greatly affects consumer acceptance of the product (Li et al., 2020). It can also be seen that sample D got the highest sensory score for crispiness and was significantly different ( $p < 0.05$ ) from all other samples. Optimum formulation of oats and malted barley flour may have created optimum water holding capacity of the product that contributed to the development of the crust crispiness (Zadeike et al., 2018).

Sample D scored the highest in overall acceptability of the sensory conducted among the panelists. It was found to be significantly different from all other samples. Thus, from sensory evaluation, the optimized product was found to be sample D whose formulation was as oats flour: malted barley flour: wheat flour :: 10: 35: 55.

### 3.3 Chemical composition of Control cookies and Optimized cookies

The chemical composition of control cookies and optimized cookies are presented in Table 3. The chemical composition of control cookies and optimized cookies was significantly different ( $p < 0.05$ ) from one to another. The moisture content of optimized

cookies was 2.88% while control was 3.42%, the lower moisture content of optimized may be due to the incorporation of barley malt flour which had quite low moisture content compared to wheat flour. The lower moisture content gives better crispiness to the cookie and also becomes less prone to microbial attack. The protein content of optimized cookies is quite higher than that of control cookies. The crude fat content of optimized cookies was higher than control cookies which may be due to the 8.3% fat content in oats flour that contributes to more fat. Both crude fiber and ash content of optimized cookies were higher than control cookies since oats and barley malt flour both have higher fiber and ash content. Other research work by Alka et al. (2017) has reported similar findings. The carbohydrate content decreased with an increase in the proportion of oats and barley malt as can be seen in their own lower carbohydrate content, supporting the claims of Ikuomola et al. (2017). The calcium content of optimized cookies was higher than that of control cookies which are contributed by the higher calcium content in both oats and barley malt compared to wheat flour (Sharma, 2015).

**Table 3:** Chemical composition of control and optimized cookies

Chemical composition	Control cookies	Optimized cookies
Moisture (%)	3.42 <sup>b</sup> ± 0.12	2.88 <sup>a</sup> ± 0.08
Crude protein (% db)	6.43 <sup>a</sup> ± 0.40	7.50 <sup>b</sup> ± 0.30
Crude fat (% db)	18.83 <sup>a</sup> ± 0.76	22.93 <sup>b</sup> ± 0.90
Crude fiber (% db)	0.83 <sup>a</sup> ± 0.02	2.90 <sup>b</sup> ± 0.20
Total ash (% db)	0.41 <sup>a</sup> ± 0.03	0.97 <sup>b</sup> ± 0.01
Carbohydrate (% db)	73.5 <sup>b</sup> ± 1.50	65.7 <sup>a</sup> ± 0.43
Calcium (mg/100 g)	18.40 <sup>a</sup> ± 1.01	35.37 <sup>b</sup> ± 1.05
Iron (mg/100 g)	3.30 <sup>a</sup> ± 0.20	3.10 <sup>a</sup> ± 0.20
Reducing sugar (%)	1.37 <sup>a</sup> ± 0.02	3.05 <sup>b</sup> ± 0.03

\* Values are the means of triplicates and figures in the parenthesis are standard deviations of the triplicates. Means in a single parameter with different alphabets are significantly different ( $p < 0.05$ ).

The iron content of optimized cookies and control cookies was not significantly different from one to another.

#### 4. Conclusion

Based on the findings in the present study, it can be concluded that Malted barley flour and oats flour together can be incorporated up to 35% and 10% respectively with 55% wheat flour, with no adverse effect on the sensory quality of cookies. The nutritional quality seemed to be enhanced in the case of protein, fat, fiber, and ash content with significant increments in calcium and reducing sugar content. The result of the work showed that cookies made with the incorporation of oats flour and malted barley flour in wheat flour enhance the nutritional quality of cookies. Similar results could be achieved through the incorporation of other grain flour in various bakery products like bread and biscuits.

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#### Conflicts of Interest

The authors declare that there is no conflict of interest.

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