

# The Effects of Wheat Flour and Barley Flour on the Quality and Properties of Biscuits Colored with Synthetic and Natural Colorants

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## Abstract

Biscuit is one of the most popular processed ready to eat snacks that have possesses several attractive features including wide consumer base, relatively less expensive, more convenient with long shelf-life and have ability to serve as vehicles for important nutrients. It's usually available in different sizes, tastes and shapes. It can also be enriched or fortified with other ingredients in order to meet specific nutritional or therapeutic needs of consumers. In recent years, numerous studies have shown the potential of utilizing natural plant such as green leafy vegetable in cookies and biscuit production; the potential of amaranthus leaves used as a source of iron and  $\beta$ -carotene in pakora, vada, namakpal, kurmure, biscuit and cake. The present research was carried out to throw the light on the effect of wheat flour and barley flour with natural and synthetic colors to improve chemical composition, the nutritional value and quality characteristics of producing biscuits. The results indicate that that treatment 100% barley flour 72% with turmeric and cocoa as a natural colors recorded a significant increase in the content of protein, ash, minerals such as iron, zinc, potassium, magnesium and some physical analysis like weight, volume, density as well as sensory evaluation. As compared with wheat flour 72% and synthetic color tartrazine ADI 7.5 mg/kg.bw and chocolate brown ADI 0.15 mg/kg.bw. In conclusion, results showed that barley flour improved nutritional quality, physical characteristics and sensory characteristics of produce biscuit with mixture natural and natural color.

**Keywords:** biscuit; chemical composition; natural colors; physical and sensory characteristics; synthetic colors

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## Introduction

Wheat (*Triticum aestivum* L.) is a cereal cultivated worldwide and has great importance in the human diet, contributing as a direct source of energy, protein, vitamins, minerals and fiber (Karl and Saltzman, 2012; Mckeown, 2013; El-Beltagi and Abdel-Rahim, 2017). Almost all wheat grains are intended for the production of flour, typically used in the preparation of breads, pastas and cakes. The bran originating from its processing has high fiber content and it is widely consumed, either directly or as an ingredient in prepared foods. Wheat flour 72% extraction contained 11.66% moisture, 11.83% protein, 1.01% fat, 0.53% ash, 0.38% fiber and 86.25% total carbohydrate (Dahab 2006).

Barley (*Hordeum vulgare*), is the world's most nutritional crop. This is because it contains many elements that rich sources of health and energy. The composition of barley, including the percentage of minerals, barley flour

contained 11.65%, 2.31%, 6.25% and 2.22% crude protein, fat, fiber and ash respectively. Another variety of barley flour contained 15% crude protein, 2.19% crude fat, 3.2% ash, 15.81% dietary fiber, 63.8% total carbohydrates and 5.62% total carbohydrates and 5.62%  $\beta$ -glucan on dry weight basis (Hassan *et al.*, 2012). Barley meal characterized by  $\beta$ -glucan, which ranged from 3 up to 7%, whereas  $\beta$ -glucan ranged from 38.9 up to 50.2 g /k g for covered barley and it was higher in hull less barley (43.8- 62.3 g/kg). Ash percentage in barley meal was between 1.92 up to 3%, these results were concluded by Abdel-Rahim *et al.* (1987).

Biscuits are convenient food products and the most popular bakery items consumed by nearly all levels of society in Egypt. Some of the reasons for such wide popularity are low cost among other processed foods, good nutritional quality and availability in different varieties and varied taste (Sudha *et al.*, 2007). The major ingredients are flour, fat, sugar and water while other ingredients such as milk, salt and aerating agent can be included.

Dyes of synthetic color are complex organic chemicals that were originally derived from coal tar, but now from petroleum. Companies prefer using them because they are cheaper, more stable, and brighter than most natural colorings. However, changing consumer preferences play an important role in how rituals and companies market their products and lead to replace synthetic coloring by heather natural coloring, such as beta-carotene (a precursor to vitamin A), paprika, beet juice, and turmeric. That trend is stronger in Europe than the United States, but some U.S. companies recognize that an "All Natural" label can attract customers and may be moving in that direction. Two recent studies sponsored by the British government on cross-sections of British children found that mixtures of four dyes (and a food preservative, sodium benzoate) impaired the behavior of even non-hyperactive children (Barrett *et al.*, 2007). The acceptable daily of Tartrazine intake (ADI) of human is 0-7.5 mg/kg/day (Walton *et al.*, 1999). The metabolism of tartrazine was well documented in animals and humans in a range of doses, the absorption of oral administration of intact less than 5% (Feng *et al.*, 2012) while, the ADI for chocolate brown is 0.15 mg/kg/day (FAO/WHO 1985).

Turmeric (*Curcuma longa*) as natural color is extensively used as spice, food preservative and coloring material. It has been used in traditional medicine as a household remedy for various diseases, including biliary disorders, anorexia, cough, diabetic wounds, hepatic disorders, rheumatism and sinusitis (Ammon and Wahl, 1991). For the last few decades, extensive work has been done to establish the biological activities and pharmacological actions of turmeric and its extracts. Curcumin (diferuloylmethane, the main yellow bioactive component of turmeric) has been shown to have a wide spectrum of biological actions. These include its antiinflammatory, antioxidant, anticarcinogenic, antimutagenic, anticoagulant, antifertility, antidiabetic, antibacterial, antifungal, antiprotozoal, antiviral, antifibrotic, antivenom, antiulcer, hypotensive and hypocholesteremic activities. Its anticancer effect is mainly mediated through induction of apoptosis. Its antiinflammatory, anticancer and antioxidant roles may be clinically exploited to control rheumatism, carcinogenesis and oxidative stress-related pathogenesis (AOAC, 2000)

Cocoa (*Theobroma cacao* L) has been reported to contain significant amount of dietary flavonoids and exhibit greater antioxidant capacity than many other flavanol rich foods (Lee *et al.*, 2003). The health benefits associated with cocoa consumption have been related to their capacity to improve the lipid profile and insulin sensitivity, diminish blood pressure, reduce platelet activity and function, ameliorate endothelial dysfunction and act as antioxidants (Monagas *et al.*, 2009). These health benefits of cocoa have been attributed to their high polyphenol compounds, mainly flavanols (Stahl *et al.*, 2009). Cocoa powder is used in confectionery products and also in non-confectionery products such as flavored milks, cereals, ice cream, cookies, biscuits, cakes, and other dessert. The aim of this study is to investigate the effect of synthetic color powder and natural color powder level and effect of mixed color on the quality characteristics and properties by wheat biscuit and barley biscuit.

## Materials and Methods

### Materials

Wheat flour (72% extraction) was obtained from Wheat Research Section Field Crops Research Institute, Agricultural Research Center, Giza, Egypt. Barley flour (naked barley) (*Hordium vulgare* L.) Giza 130, obtained from Barley Research Section, Field Crops Research Institute, Agricultural Research Center, Giza, Egypt, which was milling in the Corps Technology Institute. Sugar, shortening, vanilla, egg, baking powder and salt (sodium chloride) were obtained from the local market of Giza, Egypt. Natural color: as turmeric and cocoa powder were obtained from the local market of Giza, Egypt. Synthetic color: as tartrazine yellow and chocolate brown color were obtained from Imperial Chemical Industries. Mixed color as Tartrazine/Turmeric and Cocoa/Chocolate brown mixture were prepared by adding each one to the other in ratio of 1:1 (w/w). All chemicals used in this study were analytical grade.

### Determination of proximate analysis

Moisture, protein, fiber, lipid and ash were determined as reported in AOAC (2000). Total carbohydrate was calculated by difference.

### Determination of dietary fiber

Total dietary fiber (TDF) was determined according to the method described by Prosky *et al.* (1984).

#### Calculation:

Mg residue - [(% protein in residue + %ash in residue) × mg residue] × 100/ sample weight

### Determination of elements content

Total content of K, Na, Fe, Zn, Ca, Mg and P was determinate according to the method described by AOAC (2000).

### Determination of chromium

Chromium was determined according to the method described by Jackson *et al.* (2000).

### Biscuit formula and ingredients

Control biscuit dough was prepared according to the formula presented in Table 1 (Wade, 1988).

### Physical characteristics of biscuits

Physical characteristics were determined according to previous method described (Sai- Manohar and Rao, 1997). The diameter and thickness of five biscuits were measured by placing those edges and stacking one above the other respectively. To obtain the average, measurements were made by rearranging and restocking. The spread ratio was obtained by the ratio between diameter and thickness. The average weight of five biscuits was recorded. Volume (cm<sup>3</sup>) was determined. The bulk density was calculated and expressed as g/m<sup>3</sup>.

Spread ratio = Width/ Height

Spread factor ratio = Spread factor of sample/ Spread factor of control

Table 1. Formula of biscuit (wheat and barley) flour preparation

| Biscuit treatments | Flour | Sugar | Shortening | Dye                | Vanilla | Egg  | Baking powder | Salt |
|--------------------|-------|-------|------------|--------------------|---------|------|---------------|------|
| G1                 | 100g  | 30g   | 30g        | Less dye           | 1-2g    | 15mg | 2-3g          | 1g   |
| G2                 | 100g  | 30g   | 30g        | 7.5mg/kg (bw)/day  | 1-2g    | 15mg | 2-3g          | 1g   |
| G3                 | 100g  | 30g   | 30g        | 0.15mg/kg(bw)/day  | 1-2g    | 15mg | 2-3g          | 1g   |
| G4                 | 100g  | 30g   | 30g        | 7.5mg/kg (bw)/day  | 1-2g    | 15mg | 2-3g          | 1g   |
| G5                 | 100g  | 30g   | 30g        | 0.15mg/kg (bw)/day | 1-2g    | 15mg | 2-3g          | 1g   |
| G6                 | 100g  | 30g   | 30g        | 15mg/kg (bw)/day   | 1-2g    | 15mg | 2-3g          | 1g   |
| G7                 | 100g  | 30g   | 30g        | 0.3g/kg (bw)/day   | 1-2g    | 15mg | 2-3g          | 1g   |

G1: control biscuits less color, G2: Turmeric biscuits, G3: cacao biscuits, G4: Tartrazine color biscuits, G5: chocolate brown color biscuits, G6: Mixture tartrazine/Turmeric biscuits and G7: Mixture Cacao/chocolate brown biscuits.

### Sensory evaluation of biscuits

The sensory characteristics of biscuits were evaluated according to previous study (Farhath, 2001) and were carried out by panel of ten adults experienced Judges from the staff of the food Technology Research Institute, Agriculture Research Center, Giza, Egypt and by children. Assigning scores for various quality attributes such as: color (20), taste (20), texture (20), crust appearance (20), odor (20), overall acceptability (100).

The average total score was converted to a descriptive category as follows: very good 90 -100 [VG], good 80 < 90 [G], satisfactory 70 < 80 [S], questionable less than 70 [Q].

### Statistical analysis

Values are presented as means  $\pm$  SEM. Statistical analysis was carried out using the "costat" statistic computer program. Statistical analysis was based on One-way analysis of variance ANOVA followed by student-Newman Keuls test, and least significant difference (LSD) at  $P < 0.05$ .

## Results and Discussion

### Chemical composition of cocoa and turmeric powder

Data on chemical composition of cocoa and turmeric powder are presented in Table 2 showed that cocoa powder was higher in protein content 21.6% and lipid 55.2% and

lower in crude fiber 5.22%, dietary fiber 4.5% than that of turmeric powder, that have a protein content of 8.31%, lipid 9.10%, crude fiber 7.12%, and dietary fiber 28.12%. Farhath *et al.* (2001) reported that turmeric contains 72% water, 1.4% ash, 8.53 crud fibers, 31.21% starch.

### The chemical composition of barley flour and wheat flour

The chemical composition of wheat flour extraction and barley flour (Table 3) reflects that moisture content was higher in wheat flour 72% than in barley flour, whereas protein in wheat flour 72% was about equal of barley flour. Fat and ash contents were higher in barley flour comparing with wheat flour 72%, fiber content in barley flour was higher than that of wheat flour 72%. Chemical analysis of the raw materials indicated that carbohydrate content was higher in wheat flour 72% than that of barley flour.  $\beta$ -glucan content in barley flour represented the superiority (6.30 mg/g) as compared wheat flour. These results are in agreement with Dahab (2006) who got similar results in previous study. The primary constituents of barley kernel as reported are starch (52-71%), protein (8-13%), lipids (2-3%), non-starch polysaccharides, and protein of  $\beta$ -glucan (3-11%) (MacGregor and Fincher, 1993). Barley is now gaining a renewed interest as a functional food ingredient because it is considered as a rich source of  $\beta$ -Glucan (Brennan and Cleary, 2005).

Table 2. Chemical composition of cocoa and turmeric powder (%)

| Chemical analysis | Cocoa powder                 | Turmeric powder               |
|-------------------|------------------------------|-------------------------------|
| Moisture          | 4.2 $\pm$ 0.06 <sup>b</sup>  | 8.46 $\pm$ 0.27 <sup>a</sup>  |
| Ash               | 3.6 $\pm$ 0.04 <sup>b</sup>  | 6.51 $\pm$ 0.11 <sup>a</sup>  |
| Protein           | 21.5 $\pm$ 0.53 <sup>a</sup> | 8.31 $\pm$ 0.13 <sup>b</sup>  |
| Crude fiber       | 5.4 $\pm$ 0.09 <sup>b</sup>  | 7.12 $\pm$ 0.10 <sup>a</sup>  |
| lipid             | 45.8 $\pm$ 0.17 <sup>a</sup> | 9.10 $\pm$ 0.12 <sup>b</sup>  |
| Carbohydrate      | 15.1 $\pm$ 0.31 <sup>b</sup> | 57.68 $\pm$ 1.46 <sup>a</sup> |
| Dietary fiber     | 4.4 $\pm$ 0.05 <sup>a</sup>  | 2.82 $\pm$ 0.22 <sup>b</sup>  |

Table 3. Chemical composition of raw flour

| Chemical Composition | Moisture %                    | Protein %                     | Fat %                        | Ash %                        | Crude fiber %                | Total Carbohydrate %          | $\beta$ - Glucan |                 |                 |
|----------------------|-------------------------------|-------------------------------|------------------------------|------------------------------|------------------------------|-------------------------------|------------------|-----------------|-----------------|
|                      |                               |                               |                              |                              |                              |                               | Soluble          | Insoluble       | Total           |
| Barley flour 72%     | 7.53 $\pm$ 0.17 <sup>b</sup>  | 12.01 $\pm$ 0.23 <sup>a</sup> | 2.75 $\pm$ 0.01 <sup>a</sup> | 2.40 $\pm$ 0.02 <sup>a</sup> | 2.68 $\pm$ 0.02 <sup>a</sup> | 80.16 $\pm$ 2.11 <sup>b</sup> | 2.00 $\pm$ 0.01  | 4.30 $\pm$ 0.02 | 6.30 $\pm$ 0.02 |
| Wheat flour 72%      | 11.66 $\pm$ 0.24 <sup>a</sup> | 11.83 $\pm$ 0.19 <sup>a</sup> | 1.51 $\pm$ 0.01 <sup>b</sup> | 0.53 $\pm$ 0.01 <sup>b</sup> | 0.38 $\pm$ 0.02 <sup>b</sup> | 85.75 $\pm$ 1.99 <sup>a</sup> | ---              | ---             | ---             |

Values are mean  $\pm$  SD of the replicates

*Chemical composition of the produced biscuit*

Table 4 shows the chemical composition of biscuits contained different levels of the natural color (turmeric powder and cocoa powder), synthetic color (tartrazien and chocolate brown). From the data, it could be observed that, biscuits formulated with natural color 7.5 mg/ kg level of turmeric powder had a slightly high contents of moisture, ash, protein, fiber, fat, dietary fiber and slightly low content of carbohydrates than that of control biscuits. On the other hand, biscuits formulated with 0.15 mg/kg cocoa powder contained higher content of moisture, ash, protein, crude fiber, fat, and dietary fiber than that of biscuits control. This result is in agreement with the data of Ajibola *et al.* (2015), who found that, significant increase in moisture, ash, protein and fiber content of wheat biscuits with addition of *Moringa oleifera* leaves and cocoa powder. The moisture content of cocoa biscuits ranged from 3.05 to 3.76%. The protein and fat content varied from 10.99 to 14.73% and 13.19 to 15.00%, respectively. The ash, fiber and carbohydrate contents ranged from 2.23 to 2.63%, 2.45 to 4.35% and 64.77 to 69.86%, respectively. There was significant increase in protein and fiber content of biscuits with addition of cocoa powder with the high protein and fiber contents observed in samples compared of control. Biscuits formulated with synthetic color 7.5 mg/kg tartrazien had a slightly low content of moisture, ash, protein, crud fiber, fat, dietary fiber and carbohydrates as compared with control biscuits. The same trend for biscuits formulated with 0.15 mg/kg of chocolate brown had a slightly low contents of protein, fiber, fat, dietary fiber and slightly low content of carbohydrates than that of control biscuits. On the other hand, biscuits made mixture synthetic color and natural color had the same values of protein, fiber, fat and dietary fiber as compared with biscuits control.

*Minerals content of the produced biscuits*

The element contents of the produced biscuits formulated with the powdered of color, turmeric and cocoa are presented in Table 5. From the obtained result, it could be seen that biscuits formulated with cocoa powder had higher contents of potassium with two supplements (64.21 and 66.19), magnesium, (12.35 and 15.13), calcium (58.31 and 61.76) and phosphorus (17.50 and 19.91) mg/100g, respectively and iron (0.20 and 0.63). These results are in good agreement with those reported by Ajibola *et al.* (2015), who reported that the iron content of wheat biscuit flour was 1.57 mg%, which increased significantly when incorporated with cocoa powder.

The calcium content of biscuits increased from 29.17 mg % to 52.47 mg% when cocoa powder was added to the biscuits. The significant increase in the calcium content could be due to the presence of higher calcium content in cocoa powder. The results indicate that cocoa powder supplemented biscuits possess higher nutritive profile than the control biscuit with significant increase in protein, fiber, iron and calcium. Similar improvements in the nutritional characteristics, such as dietary fiber, protein, iron and calcium have been reported for green leafy vegetables-supplemented cookies and biscuits than that of biscuits made of chocolate brown (Drisy *et al.*, 2015). On the other hand biscuits formulated with the powder of turmeric contained potassium (74.37), magnesium (5.41mg), iron (1.66 mg), calcium (5.5 mg) and phosphorus (9.54 mg). The main mineral predominance in the powder of turmeric is chromium (700. 65 mg/100g) Table 4. Biscuits formulated with the powdered or oil of turmeric contained good values of chromium, respectively.

Table 4. Chemical composition (%) of colored wheat flour biscuit

| Biscuit treatments | Moisture                 | Ash                      | Protein                   | Crude fiber              | Fat                       | Carbohydrate              | Dietary fiber            |
|--------------------|--------------------------|--------------------------|---------------------------|--------------------------|---------------------------|---------------------------|--------------------------|
| G1                 | 4.78± 0.31 <sup>a</sup>  | 1.31 ± 0.10 <sup>a</sup> | 6.77 ± 0.41 <sup>a</sup>  | 0.22 ± 0.01 <sup>a</sup> | 13.13 ± 0.90 <sup>a</sup> | 70.63 ± 1.02 <sup>b</sup> | 3.16 ± 0.22 <sup>b</sup> |
| G2                 | 5.12 ± 0.29 <sup>a</sup> | 1.49 ± 0.09 <sup>a</sup> | 6.80 ± 0.38 <sup>a</sup>  | 0.39 ± 0.02 <sup>a</sup> | 13.38 ± 1.08 <sup>a</sup> | 68.49 ± 1.11 <sup>c</sup> | 3.88 ± 0.19 <sup>a</sup> |
| G3                 | 4.79 ± 0.27 <sup>a</sup> | 1.21 ± 0.07 <sup>a</sup> | 5.75 ± 0.32 <sup>ab</sup> | 0.21 ± 0.01 <sup>a</sup> | 13.01 ± 0.81 <sup>a</sup> | 72.83 ± 1.12 <sup>b</sup> | 2.20 ± 0.14 <sup>c</sup> |
| G4                 | 5.04 ± 0.28 <sup>a</sup> | 1.51 ± 0.10 <sup>a</sup> | 6.88 ± 0.41 <sup>a</sup>  | 0.32 ± 0.02 <sup>a</sup> | 13.90 ± 0.82 <sup>a</sup> | 68.57 ± 1.12 <sup>c</sup> | 3.78 ± 0.22 <sup>a</sup> |
| G5                 | 4.60 ± 0.36 <sup>a</sup> | 1.22 ± 0.09 <sup>a</sup> | 6.17 ± 0.40 <sup>a</sup>  | 0.20 ± 0.01 <sup>a</sup> | 9.13 ± 0.60 <sup>b</sup>  | 76.47 ± 0.94 <sup>d</sup> | 2.21 ± 0.18 <sup>c</sup> |
| G6                 | 4.78 ± 0.35 <sup>a</sup> | 1.30 ± 0.07 <sup>a</sup> | 6.78 ± 0.39 <sup>a</sup>  | 0.23 ± 0.01 <sup>a</sup> | 13.16 ± 0.71 <sup>a</sup> | 70.59 ± 0.82 <sup>b</sup> | 3.16 ± 0.19 <sup>b</sup> |
| G7                 | 4.77 ± 0.34 <sup>a</sup> | 1.31 ± 0.07 <sup>a</sup> | 6.79 ± 0.41 <sup>a</sup>  | 0.22 ± 0.01 <sup>a</sup> | 13.12 ± 0.88 <sup>a</sup> | 70.62 ± 0.71 <sup>b</sup> | 3.17 ± 0.17 <sup>b</sup> |

G1: control Biscuits less color, G2: Biscuits turmeric powdered, G3: Biscuits contained cocoa powdered, G4: Biscuits contained tartrazine, G5: Biscuits contained chocolate brown powdered, G6: Biscuits contained mixture Turmeric / Tartrazine powdered, G7: Biscuits contained cocoa/ chocolate brown powdered. Values are mean ± SD of three-replicates

Table 5. Minerals content of the colored wheat flour biscuit (mg /100g dry weight)

| Biscuit treatments | Na                         | K                          | Mg                         | Fe                        | Zn                        | Ca                        | P                         | Cr                        |
|--------------------|----------------------------|----------------------------|----------------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|
| G1                 | 0.31 ± 0.001 <sup>c</sup>  | 0.853 ± 0.005 <sup>d</sup> | 0.29 ± 0.001 <sup>c</sup>  | 0.38 ± 0.002 <sup>b</sup> | 0.01 ± 0.001 <sup>c</sup> | 38.85 ± 0.03 <sup>c</sup> | 0.98 ± 0.005 <sup>d</sup> | ---                       |
| G2                 | 1.22 ± 0.012 <sup>cd</sup> | 74.370 ± 0.53 <sup>a</sup> | 5.41 ± 0.032 <sup>d</sup>  | 1.67 ± 0.005 <sup>a</sup> | 0.19 ± 0.004 <sup>a</sup> | 35.50 ± 0.03 <sup>c</sup> | 9.54 ± 0.04 <sup>c</sup>  | 20.4 ± 0.013 <sup>a</sup> |
| G3                 | 2.91 ± 0.013 <sup>b</sup>  | 64.21 ± 0.42 <sup>c</sup>  | 12.35 ± 0.011 <sup>b</sup> | 0.20 ± 0.001 <sup>c</sup> | 0.09 ± 0.001 <sup>b</sup> | 58.31 ± 0.04 <sup>a</sup> | 17.50 ± 0.01 <sup>a</sup> | ---                       |
| G4                 | 1.34 ± 0.004 <sup>d</sup>  | 20.15 ± 0.17 <sup>c</sup>  | 5.51 ± 0.036 <sup>d</sup>  | 0.13 ± 0.001 <sup>d</sup> | 0.20 ± 0.001 <sup>a</sup> | 38.62 ± 0.03 <sup>c</sup> | 0.61 ± 0.002 <sup>e</sup> | ---                       |
| G5                 | 0.40 ± 0.001 <sup>c</sup>  | 0.96 ± 0.004 <sup>f</sup>  | 0.32 ± 0.002 <sup>c</sup>  | 0.03 ± 0.001 <sup>c</sup> | 0.02 ± 0.001 <sup>c</sup> | 37.34 ± 0.02 <sup>d</sup> | 0.89 ± 0.003 <sup>d</sup> | ---                       |
| G6                 | 3.60 ± 0.020 <sup>a</sup>  | 71.3 ± 0.41 <sup>b</sup>   | 6.96 ± 0.039 <sup>c</sup>  | 0.03 ± 0.001 <sup>c</sup> | 0.02 ± 0.001 <sup>c</sup> | 37.50 ± 0.02 <sup>d</sup> | 0.60 ± 0.002 <sup>e</sup> | 20.0 ± 0.014 <sup>a</sup> |
| G7                 | 2.61 ± 0.01 <sup>c</sup>   | 60.21 ± 0.40 <sup>d</sup>  | 13.35 ± 0.010 <sup>a</sup> | 0.10 ± 0.003 <sup>d</sup> | 0.02 ± 0.001 <sup>c</sup> | 56.31 ± 0.03 <sup>b</sup> | 16.5 ± 0.006 <sup>b</sup> | ---                       |

G1: control Biscuits less color, G2: Biscuits turmeric powdered, G3: Biscuits contained cocoa powdered, G4: Biscuits contained tartrazine, G5: Biscuits contained chocolate brown powdered, G6: Biscuits contained mixture Turmeric / Tartrazine powdered, G7: Biscuits contained cocoa/ chocolate brown powdered. Values are mean ± SD of three replicates

*Physical properties of the colored biscuits*

Physical characteristics of biscuits formulated with different levels of cocoa powder are presented in Table 6. It could be observed, that the addition of cocoa powder had a considerable slight effect on biscuit quality. The diameter and thickness slightly decreased up to the level. At the two levels (15 and 30 mg/kg) the diameter and thickness slightly decreased compared with the control. While density at all the levels of cocoa powder almost had the same values. This is possibly due to the addition of increasing levels of cocoa powder which did not affect on crispness of the produced biscuits.

From Table 6 it could be noticed that, the physical properties of biscuits formulated with different level of turmeric powder (7.5 mg/kg) had the same trend as biscuits formulated with cocoa powder. Diameter and thickness decreased by increasing the levels of turmeric powder and cocoa powder. While spread ratio increased by increasing the levels of turmeric powder and cocoa powder. While density almost the same, the density slightly increased. From the results it could be seen that increasing the density with increasing the levels of powder, indicate to the crispness had too low.

The replacement of wheat flour with increasing level of color powder decreased the spread ratio from 1.95 to 1.57 and 1.33 in turmeric 1.10 and 1.11 in tartrazine, 1.53 and 1.84 in cocoa and 1.76 and 1.72 in chocolate brown due to the decrease and increase in diameter and thickness, respectively. Similar results had been reported for cookies prepared from composite flour (Drisy et al., 2015). The observed decrease in spread ratio has been attributed to dilution of gluten and less water available for gluten hydration (Sharma et al., 2013). The use of composite flour increases dough viscosity and forms aggregates of competing with limited free water available in cookie dough (McWatters, 1978).

*Sensory characteristics of the produced biscuits*

There are significant differences between the different kind of biscuits and the different powder levels of turmeric and tartrazine (Table 7). The highest score of color was

recorded for biscuits formulated with 7.5 mg/kg levels of turmeric powder and tartrazine, while the lowest score of color was observed with biscuits formulated with mixture between turmeric and tartrazine. The addition of different levels of turmeric powder improved the taste of the prepared biscuit; there was a significant difference with mixture between turmeric and tartrazine. At the same line, there were also improved in odor of biscuits made using different levels of the powder. Crust appearance had no significant between biscuits formulated with levels of turmeric powder. While, texture of biscuits made using mixture had the highest score. The addition of turmeric powder improved the overall acceptability up to the mixture. The mixture had no accepted as the other level of turmeric and tartrazine powder.

Data pertaining to sensory evaluation of biscuits formulated with different levels of turmeric. The present results revealed that the addition of turmeric at all the studied levels improved color, crust appearance and texture. While taste and odor had improved up to mixture level of turmeric and tartrazine, biscuits made using mixture level had a significant difference with the other levels (Boskou et al., 2010). From the data in Table 7, it could be concluded that biscuits made using of the powder of turmeric were very good accepted by panelists than biscuit tartrazine powder.

The sensory characteristics of biscuits supplemented with cocoa are presented in Table 8. The sensory scores for color, odor and taste of all the supplemented biscuits were lower when compared to those of control. The color and taste of sample biscuits containing cocoa were more acceptable than those of control. This could be attributed to the addition of cocoa, which helped to mask the greenish color and improved the taste of the biscuit. Past studies had reported the changes in color. The overall acceptability scores were 97.5% and 97.4% of cocoa sample, respectively. The results show that acceptable biscuits could be prepared using the addition of cocoa powder more acceptable color and taste. The addition of cocoa powder to biscuits supplemented with cassava flour enhanced the flavor and color of the biscuits (Gyedu-Akoto and Laryea, 2013).

Table 6. Physical properties of colored wheat flour biscuits made using the natural color and synthetic color (mg /100g dry weight)

| Biscuit | Width <sup>a</sup> (cm) | Thickness <sup>b</sup> (cm) | Spread ratio <sup>c</sup>  | Spread factor <sup>d</sup> | Density g/cm <sup>3</sup> |
|---------|-------------------------|-----------------------------|----------------------------|----------------------------|---------------------------|
| G1      | 4.6 ± 0.12 <sup>a</sup> | 2.35 ± 0.08 <sup>c</sup>    | 1.95 ± 0.012 <sup>a</sup>  | 100 ± 2.71 <sup>a</sup>    | 0.64 ± 0.002 <sup>a</sup> |
| G2      | 4.1 ± 0.11 <sup>b</sup> | 2.60 ± 0.07 <sup>d</sup>    | 1.57 ± 0.011 <sup>c</sup>  | 92.01 ± 1.43 <sup>b</sup>  | 0.67 ± 0.001 <sup>a</sup> |
| G3      | 4.6 ± 0.14 <sup>a</sup> | 3.00 ± 0.10 <sup>c</sup>    | 1.53 ± 0.010 <sup>c</sup>  | 102 ± 1.99 <sup>a</sup>    | 0.64 ± 0.002 <sup>a</sup> |
| G4      | 4.2 ± 0.16 <sup>b</sup> | 3.81 ± 0.09 <sup>a</sup>    | 1.10 ± 0.010 <sup>d</sup>  | 61.03 ± 1.43 <sup>d</sup>  | 0.70 ± 0.002 <sup>a</sup> |
| G5      | 4.6 ± 0.12 <sup>a</sup> | 2.61 ± 0.06 <sup>d</sup>    | 1.76 ± 0.012 <sup>b</sup>  | 90.2 ± 2.00 <sup>b</sup>   | 0.67 ± 0.002 <sup>a</sup> |
| G6      | 4.1 ± 0.10 <sup>b</sup> | 3.59 ± 0.07 <sup>b</sup>    | 1.14 ± 0.010 <sup>d</sup>  | 58.21 ± 1.21 <sup>d</sup>  | 0.72 ± 0.002 <sup>a</sup> |
| G7      | 4.6 ± 0.12 <sup>a</sup> | 2.71 ± 0.06 <sup>d</sup>    | 1.69 ± 0.013 <sup>bc</sup> | 86.6 ± 2.00 <sup>c</sup>   | 0.65 ± 0.002 <sup>a</sup> |

G1: control Biscuits less color, G2: Biscuits turmeric powdered, G3: Biscuits contained cocoa powdered, G4: Biscuits contained tartrazine, G5: Biscuits contained chocolate brown powdered, G6: Biscuits contained mixture Turmeric / Tartrazine powdered, G7: Biscuits contained cocoa/ chocolate brown powdered.

(a) Width of 5 biscuits in series, (b) Thickness of 5 biscuits in series, (c) Width/thickness and (d) spread ratio of Sample / spread ratio of control x 100. Values are mean ± SD of three replicates.

Table 7. Sensory evaluation of colored wheat flour biscuit made using different levels of turmeric and tartrazine powder

| Biscuit | Color (20)               | Taste (20)               | Odor (20)                | Crust appearance (20)     | Texture (20)             | Overall Acceptability (100) |
|---------|--------------------------|--------------------------|--------------------------|---------------------------|--------------------------|-----------------------------|
| Control | 18.1 <sup>b</sup> ± 1.2  | 18.2 <sup>b</sup> ± 1.09 | 19.0 <sup>f</sup> ± 1.0  | 18.4 <sup>cd</sup> ± 0.97 | 18.5 <sup>bc</sup> ± 0.1 | 92.2 <sup>b</sup> ± 2.7     |
| Tu      | 18.4 <sup>ab</sup> ± 1.2 | 18.3 <sup>b</sup> ± 1.03 | 19.3 <sup>bc</sup> ± 0.9 | 18.6 <sup>c</sup> ± 1.01  | 18.7 <sup>bc</sup> ± 0.9 | 93.3 <sup>ab</sup> ± 3.0    |
| Ta      | 18.6 <sup>a</sup> ± 1.02 | 18.7 <sup>a</sup> ± 0.98 | 19.7 <sup>a</sup> ± 0.79 | 18.9 <sup>b</sup> ± 1.0   | 18.9 <sup>b</sup> ± 1.0  | 94.8 ± 3.0 <sup>ab</sup>    |
| MTT     | 18.8 <sup>a</sup> ± 1.2  | 19.3 <sup>a</sup> ± 1.10 | 20.0 <sup>a</sup> ± 1.07 | 19.4 <sup>a</sup> ± 1.0   | 19.3 <sup>a</sup> ± 1.10 | 96.8 ± 3.1 <sup>a</sup>     |

Values are mean ± SD of three-replicate control: control less color biscuits, Tu: turmeric biscuits, Ta: tartrazine biscuits, MTT: mixture tartrazine and turmeric

Table 8. Sensory evaluation of colored wheat flour biscuit made using different levels of cocoa and chocolate brown powder

| Biscuit | Color (20)                | Taste (20)                | Oder (20)                 | Crust Appearance (20)     | Texture (20)             | Overall Acceptability (100) |
|---------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|-----------------------------|
| Control | 18.1 <sup>bc</sup> ± 0.46 | 18.3 <sup>bc</sup> ± 0.50 | 18.6 <sup>cd</sup> ± 0.41 | 18.5 <sup>cd</sup> ± 0.34 | 18.2 <sup>b</sup> ± 0.29 | 95.70 <sup>a</sup> ± 1.99   |
| CO      | 18.2 <sup>bc</sup> ± 0.51 | 18.5 <sup>ab</sup> ± 0.37 | 18.8 <sup>c</sup> ± 0.31  | 18.7 <sup>c</sup> ± 0.42  | 18.3 <sup>b</sup> ± 0.31 | 96.5 <sup>a</sup> ± 2.01    |
| Cb      | 18.6 <sup>b</sup> ± 0.29  | 18.9 <sup>ab</sup> ± 0.42 | 19.2 <sup>b</sup> ± 0.50  | 19.1 <sup>ab</sup> ± 0.50 | 18.6 <sup>a</sup> ± 0.30 | 97.4 <sup>a</sup> ± 2.87    |
| MCC     | 18.9 <sup>a</sup> ± 0.46  | 19.3 <sup>a</sup> ± 0.36  | 19.7 <sup>a</sup> ± 0.37  | 19.6 <sup>a</sup> ± 0.48  | 18.8 <sup>a</sup> ± 0.29 | 96.3 <sup>a</sup> ± 2.11    |

Values are mean ± SD of three-replicates, control: control less color biscuits, CO: cacao biscuits, Cb: chocolate brown biscuits, MCC: mixture cacao and chocolate brown biscuits.

#### *The chemical composition of barley flour biscuit*

Barley has not yet been used as the main ingredient in such common food commodities as bread and biscuit. Barley grain is an excellent source of both soluble and insoluble dietary fibers. Barley  $\beta$ -glucans are recognized to have important positive health impacts. Consequently, partial replacement of wheat with whole barley may result in development of acceptable and functional products.

The proximate chemical composition of biscuit samples prepared from different samples, synthetic color and natural color is given in Table 9. Results showed that the addition of barley in the color biscuit improved the protein, ash and crude fiber of biscuit samples. Consists of the normal characteristics of biscuits, their moisture content was generally below 5%. The lower level of moisture is an important property of biscuits, which contributes to their keeping quality and crisp texture. Moisture content of biscuit samples in present study ranged from 2.32 to 4.32%, due to protein and fiber contents of barley which give high-water absorption, moisture binding capacity as well as lubricity. These results are in agreement with those obtained by Mamat *et al.* (2010) who reported that the typical initial moisture content of biscuit dough ranges from 11 - 30%, comprising both water added at the dough mixing stage and naturally occurring water in the ingredients. Thermal processing reduces the final moisture content to 1 - 5% in the final product.

It could be seen from the results that the protein, ash, fat and crude fiber contents were increased in obtaining functional biscuit samples by barley with different color. The fat content of biscuits was decreased by 2.5% and 2.3% as compared to control sample with tartrazine and mixture color.

The mean values for total dietary fiber content of biscuits are presented in Table 9. It was observed that control biscuits had 14.82% of total dietary fiber, on dry weight. Barley biscuits contained higher amount of total fiber as compared to wheat flour biscuits.

The dietary fiber constituents increased significantly ( $p \leq 0.05$ ) in biscuits containing barley. In comparison to control samples significant increase of total dietary fiber content was achieved by addition of barley these results are in agreement with those obtained by fiber of biscuit samples. Consistent with the normal previous studies showed that significant increase of total dietary fiber content was achieved by addition of 30% barley meal (Vitali *et al.*, 2007).

In Table 10 where it was observed that barley supplementation improves nutritional status of malnourished children. Desai *et al.* (2010) showed that iron

(189.3%) and calcium (12.53%) were found in barley flour biscuits when compared to control wheat flour biscuits. Results showed that minerals, especially calcium, phosphorus and iron in barley flour higher as compared to wheat flour biscuits as supported by previous studies (King *et al.*, 2008).

Table 11 showed that physical properties of colored biscuits by barley flour observed. The low moisture content for barley flour is effect on the physical properties, width, thickness and spread ratio. This parameter is very important not only for flours shelf life, but also for the determining of solids content. For many tests, it is necessary to know dry weight for the material in order to determine the amount of substances it contains (Freund and Kim, 2006).

The diameter and thickness slightly decreased with barley flour with chocolate brown and tartrazine. The diameter and thickness slightly decreased compared with the control. While density at all the biscuit colorant powder had the same values compared with the control. This is possibly due to the addition the barley improvement physical properties of colored biscuits.

#### *Sensory evaluation of functional barley biscuits*

The influence of barley flour in biscuit formula on the sensory attributes of the prepared color biscuits was studied. Results of sensory evaluation in terms of appearance of crust, texture, color, odor, taste, and overall acceptability of biscuits samples supplemented with different levels of color are presented in Table 12. It was observed that significant differences were found between biscuits samples supplemented with color by barley and the control sample. Biscuits containing of turmeric with barley flour showed mean maximum overall acceptability 90.2% compared to control barley biscuit sample 77.6%. In general, fortification of biscuits with barley flour by color significantly improved color, crust, texture than control sample.

In Table 13 biscuits were standardized by barley flour at different levels of synthetic and natural colors with different taste, color with cocoa powder, chocolate brown and mixture color, biscuits having chocolate brown and mixing color were found to be most acceptable in appearance, color, texture and overall acceptability 95.9% and 94.9% respectively. Whereas biscuit color by cocoa powder were found to be most acceptable in taste 19.4% and 19.7% for different levels. The numbers of panel with highly significant compared to control with cocoa powder. The obtained results are in good agreement with those reported by Sharma and Chopra (2015) who reported that that biscuits supplemented with a higher level of fiber from sources of barley are more acceptable than lower levels.

Table 9. Chemical composition (%) of colored barley flour biscuit contained different levels of natural and synthetic color

| Biscuit | Moisture                 | Ash                      | Protein                   | Crude fiber              | Fat                       | Carbohydrate               | Dietary fiber              |
|---------|--------------------------|--------------------------|---------------------------|--------------------------|---------------------------|----------------------------|----------------------------|
| G1      | 4.23 ± 0.10 <sup>a</sup> | 1.49 ± 0.02 <sup>b</sup> | 9.30 ± 0.21 <sup>c</sup>  | 0.43 ± 0.01 <sup>c</sup> | 14.0 ± 0.22 <sup>b</sup>  | 74.15 ± 2.00 <sup>a</sup>  | 14.82 ± 0.29 <sup>a</sup>  |
| G2      | 3.90 ± 0.08 <sup>b</sup> | 1.61 ± 0.03 <sup>a</sup> | 11.44 ± 0.24 <sup>a</sup> | 0.83 ± 0.02 <sup>a</sup> | 14.9 ± 0.39 <sup>a</sup>  | 72.15 ± 1.97 <sup>ab</sup> | 14.97 ± 0.21 <sup>a</sup>  |
| G3      | 3.91 ± 0.05 <sup>b</sup> | 1.48 ± 0.01 <sup>b</sup> | 11.40 ± 0.18 <sup>a</sup> | 0.66 ± 0.01 <sup>b</sup> | 14.9 ± 0.44 <sup>a</sup>  | 74.11 ± 1.98 <sup>a</sup>  | 14.22 ± 0.17 <sup>c</sup>  |
| G4      | 2.56 ± 0.06 <sup>c</sup> | 1.48 ± 0.02 <sup>b</sup> | 10.01 ± 0.20 <sup>b</sup> | 0.66 ± 0.02 <sup>b</sup> | 14.4 ± 0.22 <sup>ab</sup> | 73.23 ± 2.01 <sup>a</sup>  | 14.59 ± 0.18 <sup>b</sup>  |
| G5      | 4.11 ± 0.08 <sup>a</sup> | 1.40 ± 0.02 <sup>c</sup> | 9.30 ± 0.20 <sup>c</sup>  | 0.65 ± 0.01 <sup>b</sup> | 9.2 ± 0.23 <sup>d</sup>   | 72.40 ± 2.06 <sup>ab</sup> | 14.30 ± 0.11 <sup>c</sup>  |
| G6      | 2.50 ± 0.06 <sup>c</sup> | 1.39 ± 0.01 <sup>c</sup> | 10.01 ± 0.19 <sup>b</sup> | 0.45 ± 0.01 <sup>c</sup> | 10.1 ± 0.32 <sup>c</sup>  | 73.41 ± 1.89 <sup>a</sup>  | 14.12 ± 0.35 <sup>cd</sup> |
| G7      | 2.32 ± 0.05 <sup>c</sup> | 1.41 ± 0.02 <sup>c</sup> | 10.00 ± 0.17 <sup>b</sup> | 0.43 ± 0.01 <sup>c</sup> | 13.9 ± 0.40 <sup>b</sup>  | 72.44 ± 1.74 <sup>ab</sup> | 14.10 ± 0.34 <sup>cd</sup> |

G1: control Biscuits less color, G2: Biscuits turmeric powdered, G3: Biscuits contained cocoa powdered, G4: Biscuits contained tartrazine, G5: Biscuits contained chocolate brown powdered, G6: Biscuits contained mixture Turmeric / Tartrazine powdered, G7: Biscuits contained cocoa/ chocolate brown powdered. Values are mean ± SD of three-replicates (triplicates).

Table 10. Element contents of the colored barley flour biscuit made using the natural color and synthetic color (mg /100g dry weight)

| Biscuit | Na                        | K                         | Mg                        | Fe                        | Zn                        | Ca                       | P                          | Cr                       |
|---------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|--------------------------|----------------------------|--------------------------|
| G1      | 0.31 ± 0.002 <sup>f</sup> | 0.85 ± 0.01 <sup>e</sup>  | 0.29 ± 0.001 <sup>c</sup> | 1.07 ± 0.01 <sup>a</sup>  | 0.01 ± 0.001 <sup>c</sup> | 40.2 ± 0.30 <sup>d</sup> | 0.98 ± 0.004 <sup>d</sup>  | ---                      |
| G2      | 1.22 ± 0.006 <sup>d</sup> | 74.37 ± 0.41 <sup>a</sup> | 5.41 ± 0.03 <sup>d</sup>  | 1.07 ± 0.01 <sup>a</sup>  | 0.19 ± 0.002 <sup>a</sup> | 41.5 ± 0.29 <sup>c</sup> | 9.54 ± 0.051 <sup>c</sup>  | 20.4 ± 0.09 <sup>a</sup> |
| G3      | 2.91 ± 0.011 <sup>b</sup> | 64.21 ± 0.44 <sup>c</sup> | 12.35 ± 0.11 <sup>b</sup> | 1.04 ± 0.01 <sup>a</sup>  | 0.09 ± 0.001 <sup>b</sup> | 42.7 ± 0.27 <sup>b</sup> | 17.50 ± 0.21 <sup>a</sup>  | ---                      |
| G4      | 1.34 ± 0.007 <sup>d</sup> | 20.15 ± 0.11 <sup>c</sup> | 5.51 ± 0.32 <sup>d</sup>  | 1.03 ± 0.008 <sup>a</sup> | 0.20 ± 0.001 <sup>a</sup> | 40.2 ± 0.22 <sup>d</sup> | 0.61 ± 0.003 <sup>c</sup>  | ---                      |
| G5      | 0.40 ± 0.002 <sup>e</sup> | 0.96 ± 0.005 <sup>f</sup> | 0.32 ± 0.002 <sup>c</sup> | 1.03 ± 0.007 <sup>a</sup> | 0.02 ± 0.001 <sup>c</sup> | 40.1 ± 0.29 <sup>d</sup> | 0.89 ± 0.005 <sup>de</sup> | ---                      |
| G6      | 3.60 ± 0.012 <sup>a</sup> | 71.33 ± 0.46 <sup>b</sup> | 6.96 ± 0.002 <sup>c</sup> | 1.03 ± 0.009 <sup>a</sup> | 0.02 ± 0.001 <sup>c</sup> | 42.5 ± 0.28 <sup>b</sup> | 0.60 ± 0.003 <sup>c</sup>  | 20.0 ± 0.11 <sup>b</sup> |
| G7      | 2.61 ± 0.013 <sup>c</sup> | 60.21 ± 0.42 <sup>d</sup> | 13.35 ± 0.10 <sup>a</sup> | 1.03 ± 0.008 <sup>a</sup> | 0.02 ± 0.001 <sup>c</sup> | 43.1 ± 0.29 <sup>a</sup> | 16.50 ± 0.02 <sup>b</sup>  | ---                      |

G1: control Biscuits less color, G2: Biscuits turmeric powdered, G3: Biscuits contained cocoa powdered, G4: Biscuits contained tartrazine, G5: Biscuits contained chocolate brown powdered, G6: Biscuits contained mixture Turmeric / Tartrazine powdered, G7: Biscuits contained cocoa/ chocolate brown powdered. Values are mean ± SD of three replicates

Table 11. Physical properties of colored barley flour biscuit made using the natural color and synthetic color (mg /100g dry weight)

| Biscuit | Width <sup>a</sup> (cm) | Thickness <sup>b</sup> (cm) | Spread ratio <sup>c</sup> | Spread factor <sup>d</sup> | Density g/cm <sup>3</sup> |
|---------|-------------------------|-----------------------------|---------------------------|----------------------------|---------------------------|
| G1      | 4.6 ± 0.14 <sup>a</sup> | 2.35 ± 0.08 <sup>c</sup>    | 1.95 ± 0.05 <sup>a</sup>  | 100 ± 3.32 <sup>a</sup>    | 0.64 ± 0.01 <sup>b</sup>  |
| G2      | 4.1 ± 0.13 <sup>b</sup> | 2.60 ± 0.08 <sup>d</sup>    | 1.57 ± 0.06 <sup>c</sup>  | 92.01 ± 4.00 <sup>b</sup>  | 0.67 ± 0.02 <sup>b</sup>  |
| G3      | 4.2 ± 0.12 <sup>b</sup> | 3.81 ± 0.11 <sup>a</sup>    | 1.10 ± 0.03 <sup>d</sup>  | 61.03 ± 2.14 <sup>d</sup>  | 0.70 ± 0.03 <sup>a</sup>  |
| G4      | 4.6 ± 0.12 <sup>a</sup> | 3.00 ± 0.08 <sup>c</sup>    | 1.53 ± 0.02 <sup>c</sup>  | 102 ± 3.41 <sup>a</sup>    | 0.64 ± 0.02 <sup>b</sup>  |
| G5      | 4.6 ± 0.13 <sup>a</sup> | 2.61 ± 0.07 <sup>d</sup>    | 1.76 ± 0.03 <sup>b</sup>  | 90.2 ± 3.62 <sup>b</sup>   | 0.67 ± 0.02 <sup>b</sup>  |
| G6      | 4.1 ± 0.12 <sup>b</sup> | 3.59 ± 0.10 <sup>b</sup>    | 1.14 ± 0.02 <sup>d</sup>  | 58.21 ± 2.01 <sup>d</sup>  | 0.72 ± 0.03 <sup>a</sup>  |
| G7      | 4.6 ± 0.12 <sup>a</sup> | 2.71 ± 0.07 <sup>d</sup>    | 1.69 ± 0.02 <sup>b</sup>  | 86.6 ± 3.17 <sup>c</sup>   | 0.65 ± 0.02 <sup>b</sup>  |

G1: control Biscuits less color, G2: Biscuits turmeric powdered, G3: Biscuits contained cocoa powdered, G4: Biscuits contained tartrazine, G5: Biscuits contained chocolate brown powdered, G6: Biscuits contained mixture Turmeric / Tartrazine powdered, G7: Biscuits contained cocoa/ chocolate brown powdered.

(a) Width of 5 biscuits in series, (b) Thickness of 5 biscuits in series, (c) Width/thickness, (d) spread ratio of Sample / spread ratio of control x 100.

Values are mean ± SD of three replicates.

Table 12. Sensory evaluation of colored barley flour biscuits using different levels of turmeric and tartrazine powder

| Biscuit | Color (20)                | Taste (20)                | Oder (20)                 | Crust appearance (20)     | Texture (20)              | Overall Acceptability (100) |
|---------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------------|-----------------------------|
| Control | 16.93 ± 0.40 <sup>c</sup> | 16.07 ± 0.53 <sup>e</sup> | 16.00 ± 0.39 <sup>c</sup> | 17.07 ± 0.40 <sup>c</sup> | 16.47 ± 0.16 <sup>d</sup> | 77.60 ± 2.31 <sup>c</sup>   |
| Tu1     | 18.53 ± 0.29 <sup>b</sup> | 17.73 ± 0.27 <sup>b</sup> | 17.67 <sup>d</sup> ± 0.37 | 18.40 ± 0.11 <sup>b</sup> | 16.73 ± 0.22 <sup>c</sup> | 90.20 ± 1.72 <sup>a</sup>   |
| Ta1     | 18.86 ± 0.26 <sup>a</sup> | 18.20 ± 0.23 <sup>a</sup> | 17.87 <sup>d</sup> ± 0.38 | 18.80 ± 0.34 <sup>a</sup> | 17.20 ± 0.33 <sup>b</sup> | 88.27 ± 1.86 <sup>b</sup>   |
| MTT1    | 18.80 ± 0.33 <sup>a</sup> | 18.53 ± 0.3 <sup>a</sup>  | 18.13 <sup>c</sup> ± 0.32 | 18.93 ± 0.23 <sup>a</sup> | 18.07 ± 0.41 <sup>a</sup> | 87.40 ± 1.99 <sup>b</sup>   |

Values are mean ± SD of three-replicate control:control less color biscuits, Tu: turmeric biscuits, Ta: tartrazine biscuits, MTT: mixture tartrazine and turmeric

Table 13. Sensory evaluation of colored barley flour biscuit made using different levels of cocoa and chocolate brown powder

| Biscuit | Color (20)               | Taste (20)               | Oder (20)                | Crust Appearance (20)    | Texture (20)             | Overall Acceptability (100) |
|---------|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|-----------------------------|
| Control | 18.0 ± 0.17 <sup>b</sup> | 18.3 ± 0.17 <sup>c</sup> | 18.0 ± 0.18 <sup>c</sup> | 18.5 ± 0.19 <sup>c</sup> | 19.2 ± 0.21 <sup>a</sup> | 92.00 ± 0.41 <sup>c</sup>   |
| CO      | 18.2 ± 0.28 <sup>b</sup> | 19.4 ± 0.28 <sup>a</sup> | 19.2 ± 0.20 <sup>a</sup> | 19.7 ± 0.20 <sup>a</sup> | 18.9 ± 0.27 <sup>a</sup> | 95.4 ± 0.32 <sup>a</sup>    |
| Cb      | 18.7 ± 0.17 <sup>a</sup> | 18.8 ± 0.23 <sup>b</sup> | 18.2 ± 0.10 <sup>c</sup> | 19.1 ± 0.32 <sup>b</sup> | 19.1 ± 0.24 <sup>a</sup> | 93.9 ± 0.49 <sup>b</sup>    |
| MC1     | 18.9 ± 0.18 <sup>a</sup> | 18.3 ± 0.09 <sup>c</sup> | 18.7 ± 0.29 <sup>b</sup> | 19.6 ± 0.37 <sup>a</sup> | 19.4 ± 0.23 <sup>a</sup> | 94.9 ± 0.41 <sup>ab</sup>   |

Values are mean ± SD of three-replicates, control: control less color biscuits, CO: cacao biscuits, Cb: chocolate brown biscuits, MCC: mixture cacao and chocolate brown biscuits.

## Conclusions

Finally, the results of the sensory evaluation to biscuit showed that biscuits with synthetic color were most acceptable having highest overall acceptability in color, crust and texture scores than natural color. Chemical analysis of barley biscuit flour revealed that all the biscuits having significantly higher amount of protein, dietary fiber, ash and elements content than the biscuits prepared from wheat flour also a non-significant difference was found in fat content of all the biscuits. Composite flour biscuits contained significantly high amount of total dietary fiber in barley biscuits compared to wheat flour biscuits.

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