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Green coffee bean powder as a functional ingredient in biscuit: Evaluation of nutritional composition, sensory attributes, and shelf life

Aarzoo Tomar and Parvinder Kaur

Abstract
Recent scientific investigations have highlighted the preventive role of bioactive compounds found in green coffee beans (GCB) against various degenerative disorders, primarily due to their potent antioxidant activity. Green coffee beans (*Coffea arabica*) are particularly valued for their unique phytochemical profile, including chlorogenic acids, which are associated with numerous health benefits. Present study aimed to assess the effect of GCB powder incorporation on the nutritional composition, sensory characteristics, antioxidant properties, and storage stability of biscuit. Whole wheat flour was partially substituted with GCB powder at 5%, 10%, 15%, and 20% inclusion levels. The developed products were subjected to organoleptic evaluation (colour, texture, taste, aroma, and overall acceptability) using a 9-point Hedonic Scale. In addition, mineral and vitamin content were quantified, and total phenolic content (TPC) was measured to determine antioxidant enrichment. The results demonstrated that GCB supplementation had a positive impact on the sensory properties of biscuit, with the 15% level showing the highest acceptability. Significant improvements in mineral and vitamin content were observed in GCB-enriched samples, indicating enhanced nutritional value. Moreover, the TPC increased with GCB addition, confirming improved antioxidant potential. Peroxide value analysis revealed a marked reduction in lipid oxidation in treated samples compared to the control, suggesting superior shelf-life stability without compromising sensory appeal.

Keywords: Green coffee bean, biscuit, quality, minerals, vitamins

Introduction
Green coffee beans, the unroasted seeds of *Coffea arabica*, are gaining attention as a functional food ingredient due to their high content of chlorogenic acids and other bioactive compounds with strong antioxidant, anti-inflammatory, and metabolic benefits (Mekky *et al*., 2022 and Abdel-Hamid *et al.,* 2023) [19, 1]. Unlike roasted coffee, GCB retains a higher concentration of phenolic compounds, which are largely responsible for its health-promoting effects, including reduced risk of cardiovascular diseases, type 2 diabetes, obesity, and neurodegenerative disorders (Stelmach *et al.,* 2015 and Suzuki *et al.,* 2002) [31, 32].
Recent studies have demonstrated that GCB can enhance antioxidant capacity and improve lipid profiles when incorporated into food products (Lee *et al*., 2023) [16]. Green coffee has also been shown to support weight management by modulating fat metabolism and reducing oxidative stress (Shimoda *et al*., 2006 and Qi & Li, 2014) [29, 26]. As demand grows for clean-label, antioxidant-rich foods post-COVID-19, GCB is increasingly explored in novel product formulations.
The current study aimed to evaluate the effects of GCB powder supplementation on the nutritional quality, sensory properties, antioxidant activity, and shelf life of biscuit, a most consumed snack made from whole wheat flour.

Materials and Methods
Preparation of biscuit
Green coffee beans were purchased online and grounded and sieved. Green coffee bean powder obtained from grinding was used to make biscuit. In this study green coffee bean powder and whole wheat flour was used in the ratio 5:95 (Type-I), 10:90 (Type-II), 15:85 (Type-III), 20:80(Type-IV) and prepared a control biscuit using 100% whole wheat flour.

Ingredients	Control	Type-I	Type-II	Type-III	Type-IV
Whole wheat flour (g)	100	95	90	85	80
Green coffee bean Powder (g)	-	5	10	15	20
Cinnamon powder	1	1	1	1	1
Sugar (g)	50	50	50	50	50
Milk (g)	20	20	20	20	20
Ghee (g)	45	45	45	45	45
Baking Powder (g)	2	2	2	2	2

Method

- Sieve whole wheat flour and green coffee bean powder.
- Add sugar, ghee and baking powder and mix properly
- Add the refined flour green coffee bean powder and Cinnamon powder and make dough by using milk.
- Rolled on the board and cut into the shape of biscuit with the help of biscuit cutter
- Bake the biscuit for 25-30 min at 160 ^{0}C till it gets Brownish

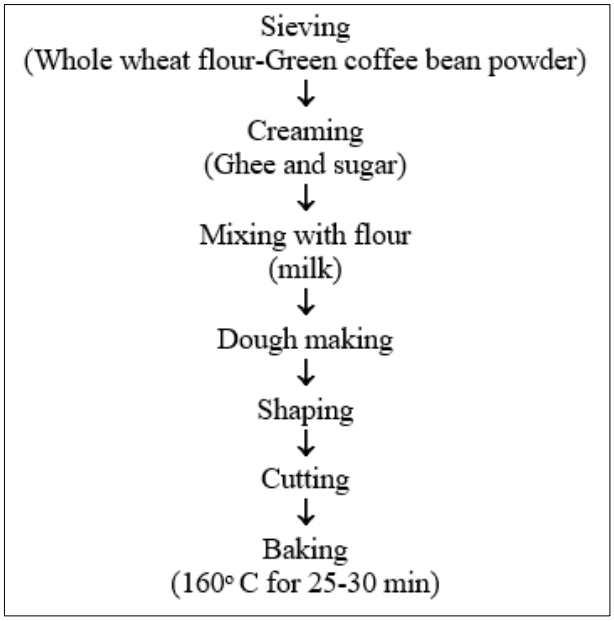

Fig 1: Flow diagram for biscuit preparation

Plate 1: Green coffee bean value added biscuit

Control=100% Refined flour
Type I= 95% Refined flour +5% Green coffee bean powder
Type II= 90% Refined flour+10% Green coffee bean powder
Type III= 85% Refined flour+15% Green coffee bean powder
Type IV= 80% Refined flour+20% Green coffee bean powder

Development of biscuit Samples

The biscuit samples were formulated in the Food Laboratory at BPS Institute of Higher Learning, BPS Mahila Vishwavidyalaya, Khanpur Kalan, Sonipat. Dough was prepared by combining whole wheat flour, green coffee bean powder (GCBP), salt, cooking oil, and water into a uniform mixture. The dough was then shaped using a biscuit cutter and baked at 160° C for 25-30 min. After baking, samples were cooled to ambient temperature and stored in airtight containers.

Five formulations were created: A control (0% GCBP) and four treatments with GCBP substituted at 5%, 10%, 15%, and 20% levels (Type I to Type IV). All samples were oven-dried at 60 °C for 24 hours prior to further analysis.

Preparation of Extracts for Phenolic Content

To determine total phenolic content, extracts were prepared by dissolving 5.5% (w/v) of each sample in hot water (93 °C) for five minutes, as per the SCAA (Specialty Coffee Association of America) protocol.

Proximate and Nutritional Analysis

- **Moisture content** was measured by drying samples at 105 °C until constant weight was obtained (Viroli *et al.,* 2008) [33].
- **Ash content** was estimated using dry ashing in a muffle furnace at 550 °C for 4 hours or until a white residue remained (SCAA Protocol).
- **Crude fat** was determined using Soxhlet extraction with hot ether (SCAA Protocol).
- **Protein content** was analyzed using the Kjeldahl method, multiplying nitrogen values by the factor 6.25 (Viroli *et al.,* 2008) [33].
- **Total dietary fiber** was measured via the enzymatic-gravimetric procedure.
- **Minerals** were assessed through acid digestion followed by Atomic Absorption Spectrophotometry (Lindsey & Norwell, 1969) [17].
- **Vitamins (ascorbic acid and β-carotene)** were quantified using standard AOAC protocols (AOAC, 2000).
- **Peroxide value** was evaluated on days 0, 45, and 90 using the AOAC method (AOAC, 2000).

Determination of Total Phenolic Content: Total phenolic content (TPC) was determined using the Folin-Ciocalteu method.

Fat Acidity

The fat acidity in the sample was estimated by employing the standard method of analysis (AOAC 2000).

Peroxide value
Peroxide value of stored product at 0, 45 and 90 days were estimated by the method proposed by AOAC (2000).

Statistical Analysis
All data were expressed as mean ± standard deviation from triplicate analyses. One-way ANOVA was applied to compare means across treatments, and differences were considered statistically significant at $p \leq 0.05$.

Result and discussion: Biscuit prepared using variable percentage of green coffee beans were examine and evaluated at various parameters for judging its acceptance, proximate composition nutritional quality, phenolic content, fat acidity and its keeping quality are as follows.

Sensory evaluation
Data on the mean scores for sensory attributes of value added biscuit depicted in Table no. 1 and figure no. 1 revealed that all types of biscuit were organoleptically acceptable. Mean scores for overall acceptability of all four types of green coffee bean value added biscuits were in the range of 7.55 to 7.99. On comparing the mean scores for taste of four types of green coffee bean biscuit, with control (7.50) was observed for Type-I, II, III and IV were 7.63, 7.88, 8.38 and 7.64, respectively. Similarly, mean scores of taste for all types enriched biscuit fell in the 'liked moderately' except Type-II & III which lied in the category of 'liked very much'. Type-III biscuit had higher acceptability scores as compared to other groups in terms of all sensory attributes i.e. colour (8.63), appearance (8.50), aroma (8.25), texture (8.38) and taste (8.38). Mean score for taste in all the groups fell in the category of 'liked moderately' except 15 percent which lies in 'liked very much' category. Results for appearance and texture showed that green coffee bean formulated biscuit fell in the category of 'liked moderately' except Type-III & IV that lied in 'liked very much' category. Desai *et al*. (2020) [11] prepared the cookies formulated by incorporation of roasted green coffee spent had better sensory attributes such as colour and aroma. Aguilar-Raymundo *et al.* (2019) [3] developed cookies by supplementing 17.5 and 25.0 g of spent coffee grounds per 100 g of refined flour, the overall acceptability of cookies has increased. Consumer appreciated the cookies texture and flavour very much, whereas Jung S. & Kang W. W. (2011) [15] baked cookies made with 1-3 percent (w/w) coffee grounds had the highest level of overall acceptability the results are similar as obtained in the present study. Ali *et al*. (2018) [5] revealed that the biscuits sensory qualities increases on addition of spent coffee but drastically reduced the colour score, whereas it not have effect on overall acceptance of the biscuits.

Table 1: Mean scores of sensory attributes of green coffee value added biscuit.

Groups	Colour	Appearance	Texture	Taste	Aroma	Overall Acceptability
Control	7.38±0.18^{a}	7.63±0.18^{a}	7.63±0.18^{a}	7.50±0.19^{a}	7.63±0.18^{a}	7.55±0.25^{a}
Type-I	7.75±0.16^{a}	8.00±0.00^{ab}	7.63±0.18^{a}	7.63±0.18^{a}	7.75±0.16^{a}	7.75±0.20^{ab}
Type-II	7.88±0.13^{a}	8.25±0.25^{b}	8.25±0.16^{a}	7.88±0.13^{a}	7.88±0.13^{a}	8.03±0.22^{b}
Type-III	8.63±0.18^{b}	8.50±0.19^{b}	8.38±0.18^{b}	8.38±0.18^{b}	8.25±0.16^{b}	8.43±0.25^{c}
Type-IV	7.80±0.19^{a}	7.94±0.19^{a}	7.75±0.16^{a}	7.64±0.23^{a}	7.85±0.16^{a}	7.79±0.25^{a}
P value ≤ 0.05	0.55	0.42	0.43	0.56	0.28	0.54

*Values are mean ± SE of ten panellist
*Values with same superscript in a column do not differ significantly CD (P≤0.05)
Control = 100% WWF Type-I= 95% WWF + 5% GCBP Type-II= 90% WWF + 10% GCBP Type-III= 85% WWF + 15% GCBP Type-IV= 80% WWF + 20% GCBP

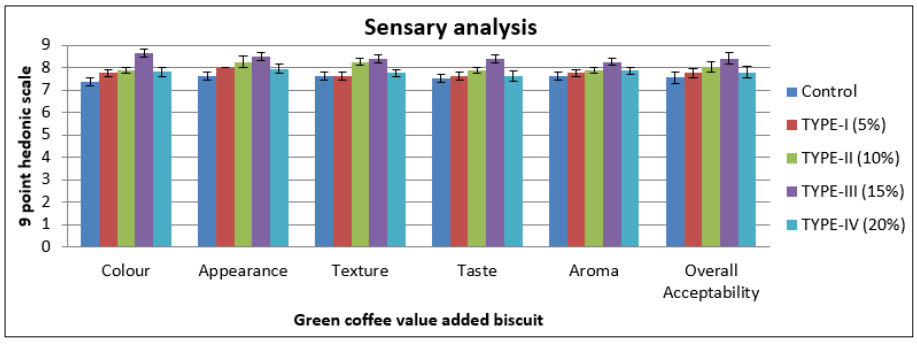

Fig 1: Mean scores of sensory attributes of green coffee value added biscuit

Chemical composition of green coffee value added biscuit
Proximate composition
Moisture: The moisture content of control, Type I, II, III and IV biscuit were 1.52, 1.85, 2.17, 2.47 and 2.73 percent respectively. Moisture content increases with addition of green coffee beans. This gradual increase may be due to the higher water absorption capacity of green coffee beans. Borrelli *et al.,* 2004 [10] documented that high water absorption capacity of GCBP, which is attributed due to its dietary fibre and hydrophilic compounds.

Crude protein: Table showed that crude protein content was 6.11, 6.33, 6.70, 6.90 and 7.05 percent in control, Type-I, II, III and IV respectively. It showed a significantly increasing as the proportion of green coffee bean powder increased, consistent with findings by Albals *et al.* (2021) [4], who reported appreciable protein levels in green coffee. Gyedu-Akoto *et al*. (2019) [12] reported that incorporation of coffee increases the protein and fat contents of the coffee biscuits.

Crude fat: The crude fat content was 27.18, 26.52, 25.40, 23.81 and 22.77 percent in control, Type-I, II, III and IV and

it was decreased progressively with the increase in green coffee bean powder concentration. Also it was statistically significant, likely due to the fat content of the green coffee bean powder, which is lower than that of the control ingredients, likely due to the lower lipid content in green coffee compared to main ingredient (Speer & Speer, 2006) [30].

Crude fibre: Table shows that crude fibre was highest in type IV i.e. 5.98 percent followed by 5.12, 3.33, 2.86 and 1.25 percent in type III, II, I and control. This increase can be attributed to the higher fibre content in green coffee bean powder compared to other ingredients.

Ash

Ash content, which reflects the mineral content of the product, increased progressively from 0.49 percent in the control to 0.99, 1.17, 1.30 and 1.41 percent in Type I, II, III and IV. This increase may indicate an increase in the mineral content due to the green coffee bean powder, which has higher mineral content compared to the original ingredients of control. These findings align with previous studies where green coffee and its by-products (such as silverskin and pulp) were used to improve the nutritional profile of baked products like cookies and biscuits (Murthy & Naidu, 2012 and Ramalakshmi & Raghavan, 1999) [21, 27].

Table 2: Chemical composition of green coffee value added biscuit

	Control	Type-I	Type-II	Type-III	Type-IV	P value ≤ 0.05
Nutritional Composition (%)						
Moisture #	1.52±0.1 8^{a}	1.85±0.20^{b}	2.17±0.14^{c}	2.47±0.17^{d}	2.73±0.13^{e}	0.21
Crude Protein	6.11±0.22^{a}	6.33±0.28^{b}	6.70±0.32^{c}	6.90±0.25^{d}	7.05±0.21^{e}	0.15
Crude Fat	27.18±1.78^{a}	26.52±2.01^{a}	25.40±1.89^{b}	23.81±1.31^{c}	22.77±1.56^{d}	0.24
Crude Fibre	1.25±0.18^{a}	2.86±0.25^{b}	3.33±0.19^{c}	5.12±0.31^{d}	5.98±0.28^{e}	0.12
Ash	0.49±0.15^{a}	0.99±0.18^{b}	1.17±0.21^{c}	1.30±0.19^{cd}	1.41±0.14^{d}	0.18
Mineral composition (mg/100gm)						
Iron	4.67±0.27^{a}	4.85±0.36^{ab}	5.05±0.24b^{c}	5.20±0.30c	5.48±0.37^{d}	0.15
Calcium	27.75±1.38^{a}	31.97±0.9^{6b}	34.55±1.21^{c}	37.82±1.67d	42.28±1.23^{e}	0.05
Zinc	1.16±0.04^{a}	1.23±0.05^{b}	1.44±0.10^{c}	1.59±0.12d	1.83±0.18^{e}	0.12
Manganese	0.69±0.12^{a}	1.40±0.16^{b}	1.83±0.18^{c}	2.18±0.24d	2.45±0.15^{e}	0.19
Vitamin composition						
Ascorbic acid (mg)	0.13±0.02^{a}	0.22±0.04^{a}	0.32±0.05^{b}	0.50±0.15^{b}	0.62±0.11^{c}	0.09
β- Carotene (µg)	0.57±0.03^{a}	2.42±0.08^{b}	5.12±0.21^{c}	6.95±0.21^{d}	8.95±0.35^{e}	0.11

Values are mean ±SE of three independent determinants # As is basis

Values with same superscripts in a column do not differ significantly CD (P≤0.05)

Control = 100% WWF Type-I=95% WWF+5% GCBP Type-II= 90% WWF + 10% GCBP Type-III= 85% WWF + 15% GCBP Type-IV= 80% WWF + 20% GCBP

Mineral composition

Iron: The highest iron content was found in Type IV it was 5.48 mg, followed by type III, II, I and control which was 5.20, 5.05, 4.85 and 4.67 mg respectively. The iron content increases with the addition of green coffee bean, suggesting that higher concentrations of green coffee bean powder contribute to higher mineral content, which supports the results of Bessada *et al.* (2018) [9] on the trace mineral content of green coffee and its by-products.

Calcium: Calcium content was maximum in type IV i.e. 42.28 mg, followed by type III, II, I and control which was 37.82, 34.55, 31.97 and 27.75 mg respectively shows a significant increase with addition of green coffee beans. The higher concentrations of calcium in the enriched biscuit products align with findings, which demonstrated that incorporating green coffee bean powder in food formulations can elevate calcium content and provide nutritional benefits.

Zinc: Zinc content was highest in Type IV which was 1.83 mg and rest of the treatment have magnesium content 1.59, 1.44 and 1.23 in type III, II and I. It was lower in control i.e. 1.16 mg.

Manganese: Manganese content was highest in Type IV which was 2.45 mg and rest of the treatment have magnesium content 2.18, 1.83 and 1.40 in type III, II and I. It was lower in control i.e. 0.69 mg and a significantly increase is observed as compared to control. Studies of Purnamayati *et al.* (2020) [25] and Savitri & Yuliani (2018) [28] also demonstrated that cookies made with green coffee bean flour not only improved nutritional content (especially minerals and antioxidants) but also maintained acceptable sensory quality. These studies support the feasibility of incorporating GCBP into baked products to enhance functional and nutritional value.

Vitamin composition

Ascorbic acid: Ascorbic acid content in control biscuit was 0.13 mg/100gm and increased in GCB- supplemented biscuit, in Type-I, II, III and IV i.e. 0.22, 0.32, 0.50 and 0.62 mg/100gm respectively. Therefore, a significant increase was observed in all the treatment groups except Type-I. This aligns with observations by Bessada *et al.* (2018) [9] and Murthy & Naidu (2012) [21].

β- Carotene: β- Carotene content increased with incorporation of green coffee bean in biscuit, from 0.57 µg/100gm to 2.24 µg (Type-I), 5.12 µg (Type-II), 6.95 µg (Type-III) and 8.95 µg/100 gm (Type-IV). The increase observed was statistically significant. Olechno *et al.* (2020) [24] also highlighted that green coffee infusions exhibit superior antioxidant potential due to higher concentrations of bioactive compounds such as β-carotene, chlorogenic acid, and vitamin C, which are preserved due to the unroasted nature of the beans.

Total phenolic content

The Total phenolic content in biscuits ranged from 13.21 to 63.65 mg GAE/100g (Gallic Acid Equivalent). The highest TPC was observed in Type IV biscuits (63.65 mg

GAE/100g), which differed significantly from the control and all other test groups. The control group had the lowest TPC value at 13.21 mg GAE/100g and significantly different from all other treatments. Mussatto *et al*. (2011) [22] reported that green coffee beans contain high concentrations of chlorogenic acids, making suitable component for cookies development. Sanchez-Gonzalez *et al*. (2017) and Bae and Suh (2018) [7] found a significant increase in TPC and antioxidant activity when green coffee bean extract was incorporated into baked products. Similarly, Macheiner *et al*. (2019) [18] observed a linear increase in TPC with increasing concentrations of green coffee extract in gluten-free biscuits, Nzekoue *et al*. (2020) [23] also documented improved TPC and antioxidant properties in cookies enriched with green coffee bean flour, with results showing proportional enhancement with rising GCB levels.

Shelf life study of stored products

Organoleptic evaluation of stored products

Green coffee bean (GCB) powder-enriched biscuits were evaluated for sensory quality after 0, 45, and 90 days of storage. The biscuits were stored in a tight container. Biscuits with moderate GCB levels (Type-III) showed the highest overall acceptability, with scores ranging from 8.43 'liked very much' on day 0 to 7.63 'liked moderately' on day 90. Type-I and II biscuits remained consistent with scores between 6.88-7.55 'liked moderately' across all storage periods. In contrast, the control sample declined from 7.55 'liked moderately' on day 0 to 6.88 'liked slightly' on day 90, and Type-IV biscuits dropped from 7.79 'liked moderately' to 6.50 'liked slightly' over the same period of time. Similar patterns were observed for taste, texture, colour, and aroma. These results were supported by studies reporting that moderate GCB incorporation improves antioxidant and sensory properties without compromising palatability (Bae & Suh, 2018; Nzekoue *et al.,* 2020) [7, 23]. However, higher GCB levels may lead to bitterness, darker colour, and firmer texture, especially after prolonged storage, as noted by Macheiner *et al.* (2019) [18] and Ibrahim *et al.* (2020) [13]. Therefore, GCBP addition up to 10-15 percent is recommended for optimal sensory and nutritional quality during shelf life.

Fat acidity

Fat acidity was evaluated to assess the shelf-life stability of biscuits enriched with green coffee bean powder (GCBP). At 0 days, the control biscuit showed the highest fat acidity (1.05 mg KOH/100g), while GCBP biscuits had lower values, by increasing GCBP levels there was a reduction in fat acidity (1.01-0.75 mg KOH/100g for 5%-20% inclusion). After 45 and 90 days, fat acidity increased in all samples due to lipid degradation, but remained lower in GCBP samples compared to control. On the 90th day, fat acidity reached 5.35 mg KOH/100g in the control and ranged from 0.75 to 4.75 mg KOH/100g in GCBP biscuits. The reduction in fat acidity with GCBP addition may be attributed to its antioxidant content, particularly chlorogenic acid, which inhibits fat oxidation. Similar findings were reported by Basu and Mishra (2017) [8], Mohamed *et al*. (2020) [20], and Sasidharan *et al*. (2019), confirming the preservative potential of green coffee in baked products (Table no.3 and Figure no.2).

Table 3: Effect of storage period on fat acidity (mg KOH/100g) on green coffee value added biscuit on 0, 45 & 90 days.

Groups	0 day	45th day	90th day
Control	1.05+0.22^{a}	3.13+0.21^{a}	5.35+0.15^{a}
Type-I	1.01+0.29^{a}	2.98+0.27^{a}	5.21+0.34^{a}
Type-II	0.96+0.31^{ab}	2.79+0.29^{a}	5.09+0.28^{ab}
Type-III	0.89+0.17^{b}	2.71+0.34^{ab}	4.91+0.25^{b}
Type-IV	0.75+0.11^{b}	2.54+0.26^{b}	4.75+0.21^{c}
P value ≤ 0.05	0.31	0.28	0.45

*Values are mean ± SE of three independent determinations

*Values with same superscript in a column do not differ significantly CD (P≤0.05)

Control = 100% WWF Type-I= 95% WWF + 5% GCBP Type-II= 90% WWF + 10% GCBP Type-III= 85% WWF + 15% GCBP Type-IV= 80% WWF + 20% GCBP

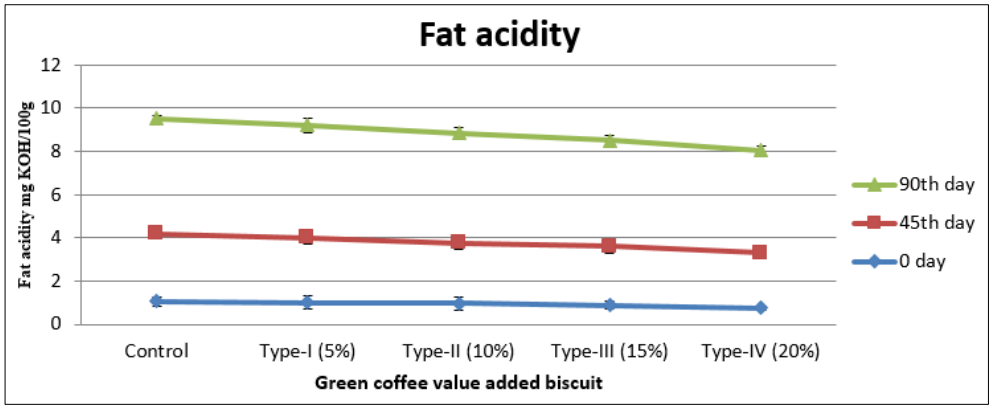

Fig 2: Effect of storage period on fat acidity (mg KOH/100g) on green coffee value added biscuit on 0, 45 & 90 days.

Peroxide value

The peroxide value (PV), an indicator of lipid oxidation, showed a decreasing trend with the addition of green coffee bean powder (GCBP) in biscuits across storage periods. On day 0, the PV ranged from 1.70 meq peroxide/1000g in the control to 1.26 meq/1000g in biscuits with 20% GCBP. After 45 days, peroxide values increased, but the GCBP-supplemented biscuits retained lower values (e.g., 1.67 meq/1000g in 20 percent GCBP) compared to the control (2.12 meq/1000g). This pattern persisted on the 90th day, where the control recorded the highest PV (3.48 meq/1000g) and the 20% GCBP sample the lowest (2.97 meq/1000g). The reduced peroxide formation in GCBP-fortified samples may be attributed to the natural antioxidants like chlorogenic acids and polyphenols in green coffee, which can inhibit lipid peroxidation. These results align with earlier findings that green coffee possesses strong antioxidant activity (Afoakwa

et al., 2014) [2], and that incorporation of phenolic-rich ingredients can improve oxidative stability in bakery products (Ibrahim *et al*., 2018; Aung *et al*., 2022) [14, 6] (Table no.4 and Figure no.3).

Table 4: Effect of storage period on peroxide composition (meq peroxide /100gm) on green coffee value added biscuit on 0, 45 & 90 days.

Groups	0 day	45th day	90th days
Control	1.70±0.11^{a}	2.12±0.15^{a}	3.48±0.29^{a}
Type-I	1.51±0.12^{b}	1.94±0.12^{abc}	3.38±0.23^{ab}
Type-II	1.45±0.09^{b}	1.87±0.11^{cd}	3.18±0.32^{cd}
Type-III	1.35±0.13^{c}	1.78±0.09^{cd}	3.07±0.20^{cd}
Type-IV	1.26±0.15^{d}	1.67±0.13^{d}	2.97±0.19^{d}
P value ≤ 0.05	0.15	0.02	0.35

*Values are mean ± SE of six independent determinations
*Values with same superscript in a column do not differ significantly CD (P≤0.05)
Control = 100% WWF Type-I= 95% WWF + 5% GCBP Type-II= 90% WWF + 10% GCBP Type-III= 85% WWF + 15% GCBP Type-IV= 80% WWF + 20% GCBP

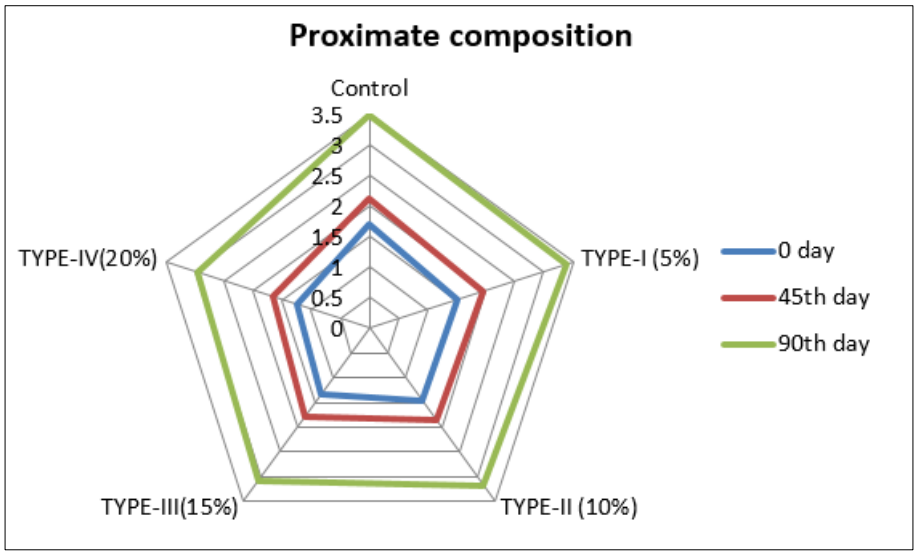

Fig 3: Effect of storage period on peroxide composition (meq peroxide /100gm) on green coffee value added biscuit on 0, 45 & 90 days

Conclusion

The addition of green coffee bean powder significantly improved the phenolic content and antioxidant activity of biscuit. The 15% supplementation level showed optimal sensory and nutritional benefits. These results demonstrate the potential of green coffee beans as a functional ingredient for developing health-oriented snack products. Further research is recommended to explore its application in other staple foods and assess long-term health effects.

References

1. Abdel-Hamid M, Goda HA, Soliman MM, Youssef MM. Influence of green coffee extract on lipid profile, antioxidant activity, and metabolic parameters: A functional food perspective. J Food Sci Technol. 2023;60(2):423-31.
2. Afoakwa EO, Paterson A, Fowler M, Ryan A. Flavor formation and character in cocoa and chocolate: A critical review. Crit Rev Food Sci Nutr. 2014;54(6):739-57.
3. Aguilar-Raymundo VG, Campos-Vega R, Nieto-Figueroa KH, Loarca-Pina G, Gonzalez de Mejia E. Development and evaluation of cookies with spent coffee grounds as a dietary fiber source. J Food Process Preserv. 2019;43(2):e13816.
4. Albals D, Tawalbeh D, Ahmad M. Functional properties and nutritional composition of green coffee beans. Food Sci Nutr. 2021;9(4):2234-41. doi: 10.1002/fsn3.2192.
5. Ali MA, El-Demery ME, El-Hariri DM. Evaluation of the nutritional and sensory quality of biscuits enriched with spent coffee grounds. Middle East J Appl Sci. 2018;8(3):945-53.
6. Aung TT, Mohamed SA, Rahman RA. Antioxidant potential and lipid oxidative stability of bakery products supplemented with functional plant extracts. J Food Process Preserv. 2022;46(3):e16348.
7. Bae IY, Suh HJ. Utilization of green coffee bean extract in cookies: Antioxidant potential and consumer acceptance. LWT - Food Sci Technol. 2018;97:232-8.
8. Basu A, Mishra S. Antioxidant preservation and lipid stability in functional cookies enriched with coffee extract. J Food Sci Technol. 2017;54(4):1102-9.
9. Bessada SMF, Alves RC, Oliveira MBPP. Coffee by-products: A review on composition, bioactivity, and applications. Food Bioprocess Technol. 2018;11(7):1749-62.
10. Borrelli RC, Visconti A, Mennella C, Anese M, Fogliano V. Chemical characterization and antioxidant properties of coffee melanoidins. J Agric Food Chem. 2004;52(24):7330-6.
11. Desai AD, Desai DR, Patel KH, Patel VN, Patel MD. Utilization of roasted green coffee spent in the preparation of cookies. Int J Curr Microbiol Appl Sci. 2020;9(7):1085-93.

12. Gyedu-Akoto E, Owusu M, Appiah F. Formulation and quality evaluation of biscuits produced from coffee husk and flour blends. Am J Food Sci Nutr. 2019;6(1):8-14.
13. Ibrahim AH, El-Faham SY, Karam MA. Effect of green coffee addition on the antioxidant activity and sensory properties of biscuits. Plant Arch. 2020;20(2):6437-42.
14. Ibrahim MI, Hussain M, Nisa S. Evaluation of antioxidant activity and oxidative stability in cookies fortified with natural plant phenolics. J Food Meas Charact. 2018;12(3):1681-9.
15. Jung S, Kang WW. Effect of coffee grounds on quality characteristics of cookies. Korean J Food Cult. 2011;26(5):567-72.
16. Lee HY, Kim JY, Park SY. Development of antioxidant-enriched snack bars using green coffee bean extract. Food Sci Biotechnol. 2023;32(1):145-52.
17. Lindsey WL, Norwell MA. A new DPTA-TEA Soil test for zinc and iron. Agron Abstr. 1969;61:84-9.
18. Macheiner L, Adam G, Mittermaier B. Functional cookies enriched with green coffee bean extract: Physical and antioxidant properties. Food Chem. 2019;272:682-8.
19. Mekky AM, Mahdy WA, Salem AM. Functional and nutritional characteristics of bakery products fortified with green coffee bean powder. Int J Food Sci Nutr. 2022;73(5):623-31.
20. Mohamed SA, El-Hadad MA, Khalil AA. Stability and acceptability of bakery products enriched with green coffee extract during storage. J Food Process Preserv. 2020;44(2):e14300.
21. Murthy PS, Naidu MM. Sustainable management of coffee industry by-products and value addition—A review. Resour Conserv Recycl. 2012;66:45-58.
22. Mussatto SI, Ballesteros LF, Martins S, Teixeira JA. Extraction of antioxidant phenolic compounds from spent coffee grounds. Sep Purif Technol. 2011;83:173-9.
23. Nzekoue FK, Angeloni S, Navarini L, Sagratini G, Maggi F. Green coffee bean flour as a novel functional ingredient in biscuits: Impact on quality and antioxidant potential. Food Chem. 2020;331:127297.
24. Olechno E, Puścion-Jakubik A, Markiewicz-Żukowska R, Socha K. Green coffee infusion as a source of bioactive compounds with antioxidant activity. Nutrients. 2020;12(2):485.
25. Purnamayati L, Rosida R, Yuliani R. Functional properties and organoleptic quality of cookies supplemented with green coffee bean flour. Int J Sci Technol Res. 2020;9(1):1304-7.
26. Qi Y, Li Y. Green coffee bean extract and its role in obesity management: A clinical review. Nutr J. 2014;13(1):62. doi: 10.1186/1475-2891-13-62.
27. Ramalakshmi K, Raghavan B. Caffeine in coffee: Its removal. Why and how? Crit Rev Food Sci Nutr. 1999;39(5):441-56.
28. Savitri S, Yuliani R. Sensory and nutritional evaluation of cookies enriched with green coffee flour. Indones J Nutr Food. 2018;13(2):137-42.
29. Shimoda H, Seki E, Aitani M. Inhibitory effect of green coffee bean extract on fat accumulation and body weight gain in mice. BMC Complement Altern Med. 2006;6:9.
30. Speer K, Speer E. Lipids in coffee. Braz J Plant Physiol. 2006;18(1):201-16.
31. Stelmach E, Pohl P, Szymczycha-Madeja A, Welna M, Jamroz P. Comparative evaluation of the antioxidant activity of green and roasted coffee beans conditioned by their origin and the brewing method. J Food Sci Technol. 2015;52(10):5730-8.
32. Suzuki A, Kagawa D, Ochiai R, Tokimitsu I, Saito I. Green coffee bean extract and its antihypertensive effects in humans. Hypertens Res. 2002;25(1):99-107.
33. Viroli SLM, Rodrigues FM, de Sousa PJ, Pereira PVD. Scientific initiation. 2008.