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Supplementation of green coffee bean powder in *sev* - its nutritional, organoleptic and shelf life evaluation

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Abstract
Scientific researches have disclosed that components present in green coffee play important preventive role against various degenerative diseases. Green coffee beans (GCB), in particular, are characterized by its unique composition and properties that are beneficial for good health. The objective of this work was to investigate the impact of green coffee beans (*Coffea arabica*) in addition on the quality and antioxidant properties of the *sev*. For *sev* preparation, Bengal gram flour and GCB were used. Bengal gram flour was replaced with GCB flour at 5, 10, 15 and upto 20% levels. Colour, texture, taste, aroma and sensory properties of *sev* were determined. Mineral and vitamin were assessed. Furthermore, total phenolic content was evaluated. The results showed that *sev* supplementation with GCB had positive influence on sensory parameters. *Sev* incorporated with 15% of green coffee bean powder had maximum acceptability. The mineral and vitamin present in *sev* has increased significantly as a result of the GCB addition. The addition of GCB significantly enriched *sev* with phenolic compounds. However supplementation of GBC has decreased peroxide value significantly when compared with control representing better storage quality. Moreover, the GCB addition enhanced the nutritional quality and shelf life *sev*.

Keywords: Green coffee bean, *sev*, quality, minerals, vitamins

Introduction
Green coffee beans have a very complex matrix of many compounds which can interact with the human body and is beneficial for human health, e.g. improving body antioxidant activity and stimulating the neural system. Many more research reported the health benefits of coffee consumption, ranging from enhancing mental performance to fighting cardiovascular disorders, carcinoma and diabetes, which mainly contribute to the rising global coffee demand (Lim *et al.*, 2012; Qi and Li, 2014; De Oliveira *et al.*, 2016) [10, 12, 7]. During past few decades, coffee consumption was also shown to be helpful in reducing a risk of social disease, such as Parkinson, diabetes type II, and Alzheimer diseases (Chu, 2012) [10]. Presently after COVID-19 because of a pro-health and pro healing status of antioxidant rich products, another coffee beverage has begun to enjoy a great popularity - mainly infusion, prepared using raw and unroasted green coffee beans. Green coffee is also believed to accelerate metabolism and therefore it can be helpful in reducing weight and preventing overcoming obesity (Stelmach *et al.*, 2015) [17]. Physiological studies made on mice suggest that a green coffee bean extract could be an effective fat absorption inhibitor and a suppressor of its metabolism in liver (Shimoda, *et al.*, 2006) [14]. It has been recognized that benefits of consuming green coffee are mainly related due to the presence of phenolic compounds in it, especially chlorogenic acids, which exhibits an antioxidant activity (Suzuki *et al.*, 2002) [18]. Green coffee beans (GCB) have a mild, green, bean-like aroma; the characteristic aroma of coffee manly develops during the roasting process. The main constituents of GCB are carbohydrates, soluble (galactomannan, arabinogallactan), and insoluble (cellulose), phenolic species, polysaccharides, proteins, polyphenols, melanoids, lipids, and minerals (Stelmach *et al.*, 2015) [17]. Green coffee beans are rich in phenolic acids, especially in chlorogenic acid, and its related compounds that show hypotensive effects (Shimoda *et al.*, 2006) [14]. Chlorogenic and caffeic acids, the main phenolics of green coffee, exhibit antimutagenic, anticarcinogenic and antioxidant activities *in vitro*, which are linked with the ability to scavenge reactive oxygen species. Additionally, these compounds have

been suggested as inhibitors of inflammation and tumor promotion via deactivation of a range of pro-oxidative enzymes such as lipoxygenase - a key enzyme of the arachidonic acid metabolism (Gawlik-Dziki *et al.*, 2013) [9]. During roasting process, there is a progressive destruction and transformation of chlorogenic acids with 8-10% (Clifford, 1999) [5]. Hence, GCB seem to be a better source of these compounds. A few studies have been conducted regarding food supplementation by GCB addition. Our recent study showed that powdered GCB may be used directly, without extract preparation, for *sev* supplementation obtained from Bengal gram flour. The aim of the present study was to examine the influence of GCB on the nutrition quality and shelf life of *sev*.

Materials and methods

Preparation of *sev*

Green coffee beans were purchased online and grounded and sieved. Green coffee bean powder obtained from grinding was used to make *sev*. In this study green coffee bean powder and black gram 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 *sev* using 100% bengal gram flour.

Ingredients	Control	Type-I	Type-II	Type-III	Type-IV
Bengal gram flour (g)	100	95	90	85	80
Green coffee bean powder (g)	-	5	10	15	20
Cinnamon powder	1	1	1	1	1
Salt (g)	3	3	3	3	3
Cooking oil (ml)	5	5	5	5	5
Water (ml)	60	60	60	60	60
Cooking oil	For frying				

The *sev* were developed at Food Laboratory in BPSIHL of BPS Women University, Khanpur Kalan Sonipat. To prepare the *sev* the dough was prepared using bengal gram flour, green coffee bean powder, salt, cooking oil and water mixed to a homogenous mass. The *sev* were made using *sev* making machine by frying in cooking oil. Once fried, the *sev* were cooled to room temperature and stored in air tight container.

- All samples control, Type-I, Type-II, Type-III & Type-IV were pre-dried in an oven for 24 h at 60 ^{0}C, and used for in subsequent analysis.
- For analysis of total phenolic content, extract were prepared using 5.5% (w/v)of the sample in contact for 5 min with water at 93 ^{0}C (SCAA Protocol).

Analysis of chemical composition

To determine the chemical composition: the moisture content was determined in an oven at 105 ºC until a constant weight was obtained (Viroli *et al.*, 2008) [19] the ash content was determined through muffle furnace incineration at 550 °C for 4 h or until the ash was completely white (SCAA Protocol). The lipids or fat were determined through hot ether extraction in Soxhlet (SCAA Protocol). The proteins were determined using the Kjeldahl method, which was based on the determination of nitrogen and multiplication by the conversion factor (6.25) of nitrogen into protein (Viroli *et al.*, 2008) [19] the total dietary fiber was determined using the enzymatic gravimetric method (Asp *et al.*, 1983) [2]. Vitamin were estimated by acid digestion, sample were determined by Atomic Absorption Spectrophotometer standard method (Lindsey and Norwell, 1969) [11]. Vitamins: Ascorbic acid and β-carotene in the sample were estimated by applying the standard method of analysis given by AOAC (2000). Peroxide value of sorted product at 0, 45 and 90 days were estimated by the method proposed by AOAC (2000).

Analysis of total phenolic compounds

Phenolic compounds were analyzed using the Folin-Ciocalteu method with gallic acid as the analytical standard and spectrophotometric absorbance measurement at 770 nm (Singleton *et al.*, 1999) [15]. The extract aliquot (600 µL) of the diluted sample (1:50 (v/v)) was transferred to a 15 mL Falcon® tube with 3000 µL of 10% (v/v) Folin-Ciocalteu reagent. After 5 min, 2250 µL of 7.5% potassium carbonate solution (w/v) was added. The mixture was stored at room temperature and protected from light for 40 min for subsequent spectrophotometric measurements. In the quantification of total phenolic compounds, the calibration curve was constructed based on the gallic acid standard, with known concentrations, in triplicate, and a linear response was observed in the range of 0.50-40.0 mg L-1 of gallic acid and described by the following equation: A=0.0018+0.0115 C (mg L-1).

Statistical analysis

The content of the investigated compounds (colour, appearance, texture, taste, aroma, overall acceptability, moisture, ash, crude fat, crude proteins, crude fibre, vitamin, mineral, peroxide value and total phenolic compounds) was calculated. The results were statistically analyzed using analysis of variance (ANOVA) values with $p \leq 0.05$ were considered statistically significant. The analyses were performed and the results are expressed as the mean±standard deviation.

Result and discussion

Sev 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

The mean score of colour, appearance, texture, taste, aroma and overall acceptability of control on day 0 was 7.50, 7.63, 7.75, 7.63, 7.38 and 7.58 respectively this indicates that these were in the liked very moderately category, after incorporation of 5% (Type-I) green coffee bean powder it was 7.88, 7.75, 7.88, 7.88, 7.63 and 7.80 respectively, this implied that these were too included in the liked moderately category. On addition of 10% (Type-II) green coffee bean powder it was 8.25, 8.25, 8.13, 8.13,8.00 and 8.15 respectively, gave the indication that this lies in liked very much category. However as green coffee bean powder was increased up to 15% (Type-III) it was 8.38, 8.38, 8.25,

8.63,8.25 and 8.38 respectively and lies in liked very much range according to 9- point hedonic scale. Furthermore more incorporation of green coffee bean powder up to 20% (Type-IV) it was 8.18, 7.69, 7.75, 7.75,7.48 and 7.77 respectively showed that these were in liked moderately category but the mean scores decreases significantly in all characteristics after 20% incorporation (Table 1 & Figure 1). It was concluded that on addition of 5%, 10%, 15% the mean score increase after adding green coffee bean powder but it decrease as it was increased upto 20%. The Judges liked the green coffee bean incorporated *sev* due to its attribute like colour, appearance, texture, taste and, Type-III product was the most liked and acceptable product among all groups.

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

Groups	Colour	Appearance	Texture	Taste	Aroma	Overall Acceptability
Control	7.50±0.19^{a}	7.63±0.18^{a}	7.75±0.18^{a}	7.63±0.18^{a}	7.38±0.18^{a}	7.58±0.18^{a}
TYPE-I (5%)	7.88±0.13^{ab}	7.75±0.16^{a}	7.88±0.13^{a}	7.88±0.13^{a}	7.63±0.18^{a}	7.80±0.15^{ab}
TYPE-II (10%)	8.25±0.16^{b}	8.25±0.16^{ab}	8.13±0.23^{ab}	8.13±0.13^{ab}	8.00±0.19^{ab}	8.15±0.17^{b}
TYPE-III (15%)	8.38±0.18^{b}	8.38±0.18^{b}	8.25±0.16^{b}	8.63±0.18^{b}	8.25±0.16^{b}	8.38±0.17^{c}
TYPE-IV (20%)	8.18±0.18^{ab}	7.69±0.18^{a}	7.75±0.16^{a}	7.75±0.16^{a}	7.48±0.13^{a}	7.77±0.16^{a}
P value ≤ 0.05	0.32	0.61	0.44	0.54	0.28	0.37

*Values are mean ± SE of ten panellist *Values with same superscript in a column do not differ significantly CD (P≤0.05)

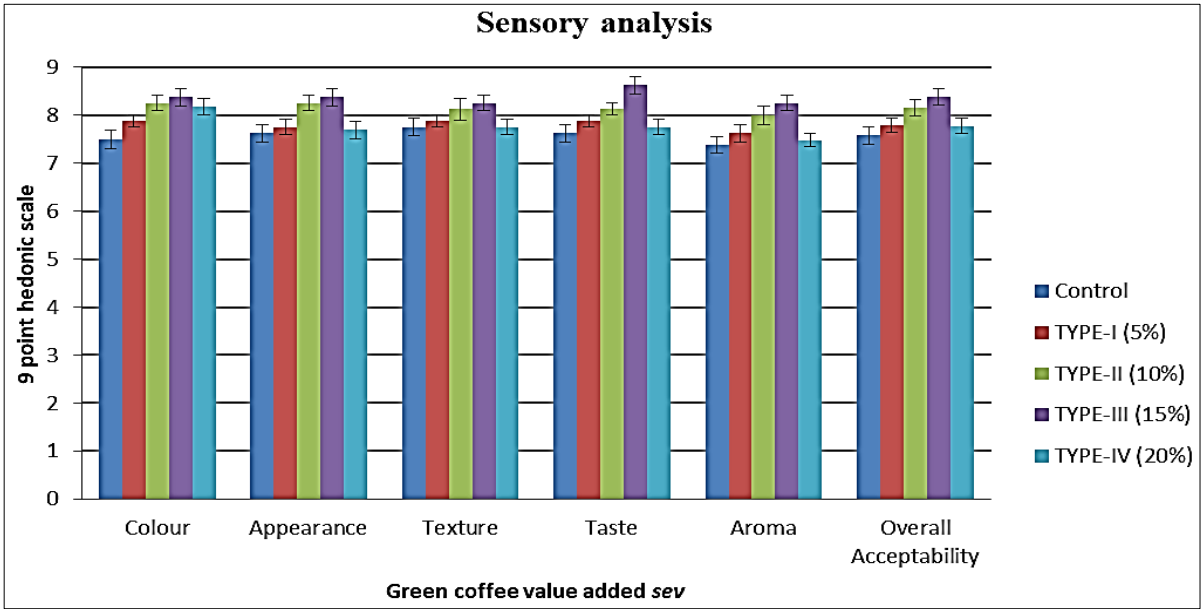

Fig 1: Mean scores of sensory attributes of green coffee value added *sev*.

Chemical composition

Table 2: Chemical composition of green coffee value added *sev*.

Sev	Control	Type-I (5%)	Type-II (10%)	Type-III (15%)	Type-IV (20%)	P value ≤ 0.05
Nutritional Composition (%)						
Moisture #	4.65±0.15^{a}	4.83±0.20^{b}	5.05±0.25^{bc}	5.17±0.15^{cd}	5.26±0.31^{d}	0.56
Crude Protein	14.41±0.13^{a}	14.15±0.38^{b}	14.08±0.26^{b}	13.79±0.19^{c}	13.41±0.31^{d}	0.41
Crude Fat	15.58±0.39^{a}	15.33±0.68^{b}	15.17±0.52^{b}	14.89±0.16^{c}	14.57±0.13^{d}	0.21
Crude Fibre	0.75±0.12^{a}	1.81±0.15^{b}	2.96±0.26^{c}	3.52±0.13^{d}	4.20±0.15^{e}	0.35
Ash	3.39±0.15^{a}	3.54±0.16^{ab}	3.62±0.25^{bc}	3.80±0.21^{c}	4.08±0.19^{d}	0.27
Mineral composition (mg/100 gm)						
Iron	3.61±0.29^{a}	3.85±0.19^{ab}	4.23±0.23^{bc}	4.78±0.25^{c}	5.03±0.27^{d}	0.17
Calcium	28.65±1.79^{a}	32.72±1.27^{ab}	36.63±1.78^{bc}	40.08±1.44^{bc}	46.18±1.38^{c}	0.24
Zinc	0.97±0.17^{a}	1.08±0.18^{ab}	1.18±0.14^{ab}	1.27±0.21^{ab}	1.41±0.25^{b}	0.12
Manganese	0.55±0.12^{a}	1.14±0.25^{b}	1.57±0.26^{c}	2.19±0.33^{d}	2.58±0.24^{e}	0.34
Vitamin composition						
Ascorbic acid (mg)	1.08±0.14^{a}	1.10±0.17^{a}	1.25±0.18^{ab}	1.30±0.21^{bc}	1.45±0.16^{c}	0.11
β- Carotene (µmg)	2.70±0.36^{a}	3.95±0.75^{b}	5.10±0.61^{c}	6.25±0.41^{d}	7.34±0.43^{e}	0.21

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

Following the addition of green coffee beans, the chemical composition was determined (Table no. 2). Compared to the control group, nutritional profile of the green coffee-based *sev* had low percentage of crude fat but higher percentage of

moisture, ash, crude protein and crude fibre, and the nutritional value improved proportionately to the amount of green coffee beans. Incorporation of green coffee also increased the mineral and vitamin composition i.e. iron, calcium, zinc & manganese and ascorbic acid & β-Carotene.

Total phenolic content

Total phenolic content (TPC) in *sev* ranges from 12.20 to 51.28 g GAE (Gallic Acid Equivalent)/100 gm. It was highest recorded in type IV i.e. 51.28 mg GAE/100 gm and it also differ significantly with control and rest of the treatment groups (Table no. 3 and Figure No.2).

Table 3: Total phenolic content of green coffee value added *sev* (GAE (Gallic Acid Equivalent)/100 gm).

Groups	*Sev*
Control	12.20±4.58[a]
Type-I	22.68±6.27[b]
Type-II	35.65±5.14[c]
Type-III	47.68±4.71[d]
Type-IV	51.28±4.26[e]
P value	0.69

*Values are mean ± SE of three independent determinations.
*Values with same superscript in a column do not differ significantly CD (P≤0.05)

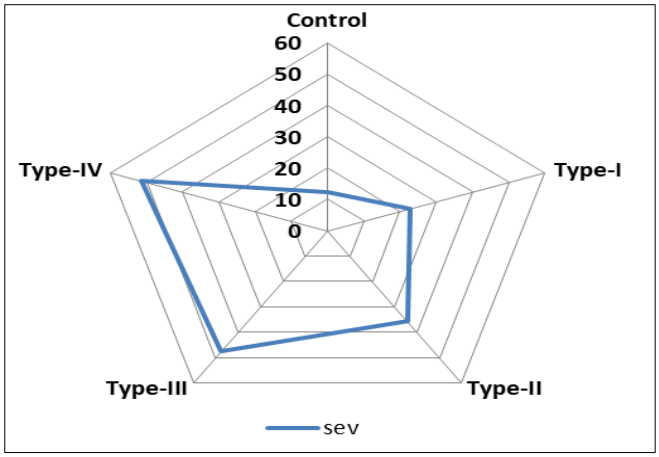

Fig 2: Total phenolic content of green coffee value added *sev* (GAE (Gallic Acid Equivalent)/100 gm).

Effect of storage on over all acceptability: The Green coffee bean base *sev* were packed in air tight container and then stored at room temperature for another 90 days. The *sev* were also evaluated for sensory characteristic using 9-point hedonic scale on 45th and 90th day. The overall acceptability of *sev* was higher on day 0 then on 45th day followed by 90th day depicted in table no. 4 and figure no 3.

Table 4: Overall acceptability of value added *sev* on day 0th, 45th day and 90th day of control, Type-I, Type-II, Type-III and Type-IV *sev*

Groups	Control	Type-I	Type-II	Type-III	Type-IV
0 day	7.58±0.18[a]	7.80±0.15[a]	8.15±0.17[a]	8.38±0.17[a]	7.77±0.16[a]
45 days	7.25±0.18[ab]	7.35±0.21[a]	7.78±0.18[ab]	7.93±0.18[ab]	6.95±0.16[ab]
90days	6.88±0.16[b]	7.00±0.20[b]	7.35±0.18[b]	7.50±0.18[b]	6.60±0.20[a]

*Values are mean ± SE of ten panellists. Value with same superscripts in a column do not differ significantly CD (*P*≤0.05)

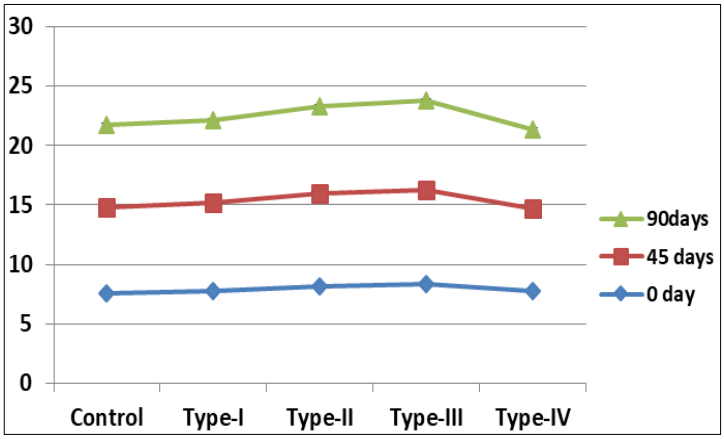

Fig 3: Overall acceptability of value added *sev* on day 0th, 45th day and 90th day of control, Type-I, Type-II, Type-III and Type-IV *sev.*

Peroxide value: The peroxide value increases as the storage days increases but it's significantly lower in all the treatment groups as compared to control groups. Hence it manifests that addition of green coffee beans in *sev* reduces the peroxide value of the value added product and increases its shelf life as shown in table no.5 and figure no. 4.

Table 5: Effect of storage period on Peroxide composition (meq peroxide /100 gm) on green coffee value added biscuit on 0, 45 & 90 days.

Groups	0 day	45 day	90 days
Control	1.36±0.03[a]	3.64±0.03[a]	5.56±0.07[a]
Type- I	1.25±0.01[b]	3.42±0.05[b]	5.30±0.12[b]
Type- II	1.18±0.00[bc]	3.25±0.03[c]	4.97±0.06[c]
Type -III	1.11±0.03[cd]	3.07±0.10[d]	4.77±0.08[c]
Type -IV	1.02±0.08[d]	2.91±0.04[d]	4.52±0.07[d]
P value	0.02	0.17	0.34

Values are mean ± SE of three independent determinations, Values with same superscript in a column do not differ significantly CD (P≤0.05)

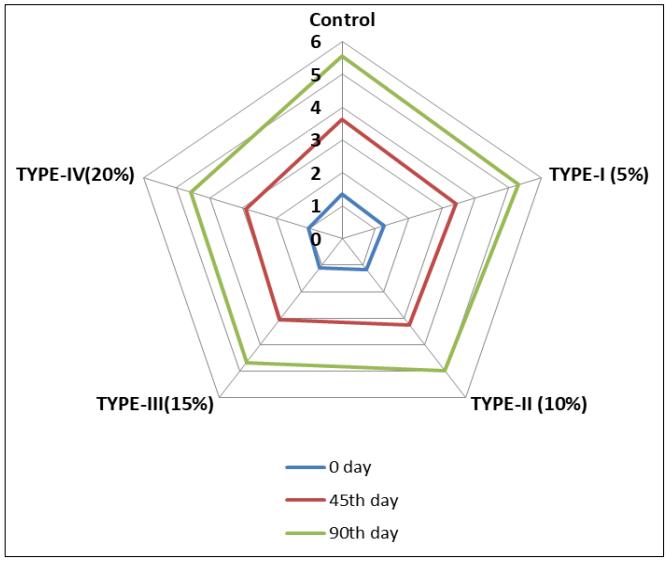

Fig 4: Effect of storage period on Peroxide composition (meq peroxide /100 gm) on green coffee value added biscuit on 0, 45 & 90 days.

Fat acidity

- The prepared green coffee *sev* were assessed for chemical analysis to evaluate the fat acidity and result is being depicted in table 8 & figure 8.
- Fat acidity: The fat acidity content of control sev on 0 day was 1.63 mg KOH/100 g while it was slightly lesser in all the four cases of supplemented sev as 5%, 10%, 15% & 20% supplemented *sev* contained i.e. 1.56, to 1.42, 1.35 & 1.21 mg KOH/100 g fat acidity respectively.
- Control, 5%, 10%, 15% and 20% of 4.22 mg KOH/100 g, to 3.85, to 3.75, 3.63 and 3.51 mg KOH/100 g respectively on 45th day of storage.
- On 90th day, the fat acidity content of control *sev* was 6.75 mg KOH/100 g while it was slightly lesser in all the four cases of green coffee supplemented *sev* as 5%, 10%, 15% and 20% supplemented *sev* contained 6.75 to, 6.41, 5.91 and 5.78 mg KOH/100 g fat acidity respectively.
- In the control samples of *sev* the fat acidity value was higher but after the incorporation of green coffee the value of fat acidity decreases.

Table 6: Effect of storage period on fat acidity (mg KOH/100 g) content on green coffee value added *sev* on 0, 45 & 90 days.

Groups	0 day	45th day	90th day
Control	1.63+0.21^{a}	4.22+0.21^{a}	6.75+0.19^{a}
Type-I (5%)	1.56+0.24^{a}	3.85+0.25^{a}	6.41+0.31^{a}
Type-II (10%)	1.42+0.31^{ab}	3.75+0.29^{a}	6.18+0.28^{b}
Type-III (15%)	1.35+0.19^{b}	3.63+0.35^{ab}	5.91+0.18^{b}
Type-IV (20%)	1.21+0.23^{c}	3.51+0.21^{b}	5.78+0.26^{c}
P value ≤ 0.05	0.21	0.35	0.29

*Values are mean ± SE of three independent determinations *Values with same superscript in a column do not differ significantly CD (P≤0.05)

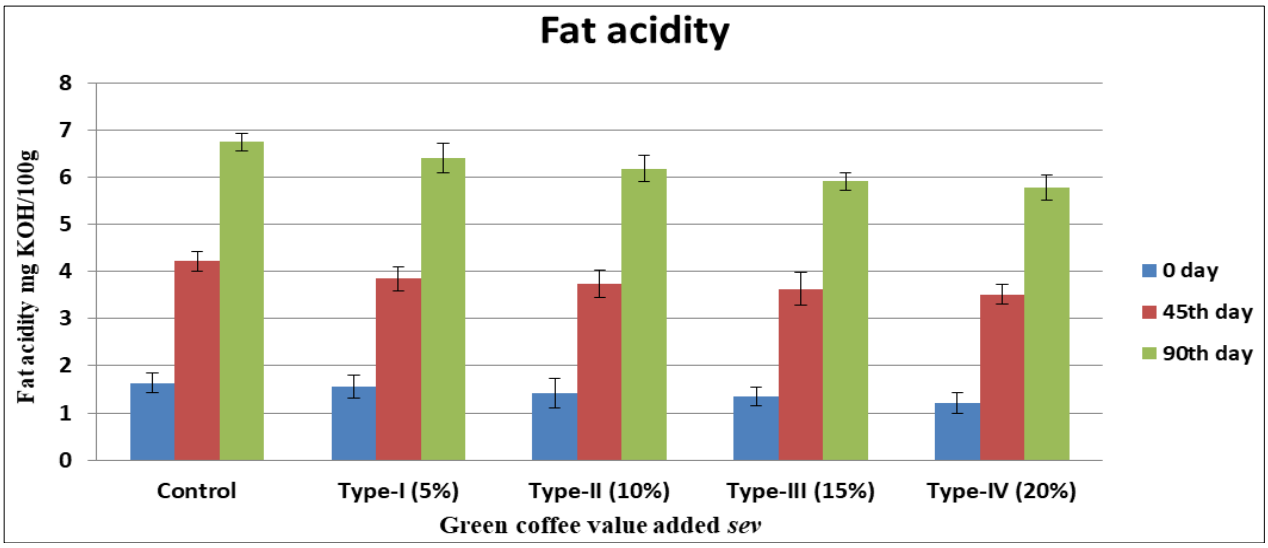

Fig 5: Effect of storage period on fat acidity (mg KOH/100 g) content on green coffee value added *sev* on 0, 45 & 90 days.

Das *et al.* (2024) [6] reported that addition of green coffee beans in bread enhanced antioxidant and antimicrobial properties in GCB incorporated formulations compared to Control. The sensory evaluation showed an enhanced appearance and aroma in treatment groups as compared to others. Overall treatment group showed better physicochemical, biological, and sensory properties than the other formulations. Zain *et al.* (2018) [20] investigation shows that the benefits of adding different concentrations of grounded green coffee beans (GCB) powder (3%, 5% and 7%) to wheat flour dough prior to baking at 220 °C for 30 min compared to control (0% of GCB) and commercially available bread. Sample was analyzed for total phenolic content (TPC), antioxidant activates (DPPH radical scavenging activity (IC_{50}) and ferrous ion chelating (FIC) ability) and organoleptic properties. The highest TPC was observed in 7% GCB bread (1.61 ± 0.06 mg GAE/g) which also recorded the highest DPPH (2.80 ± 0.06 mg/ml; IC_{50}) and FIC (0.49 ± 0.01 mg EDTA/g). GCB bread (3%) showed the highest organoleptic scores among the GCB

bread. In conclusion, GCB may be used in formulating functional bread which impacts high antioxidant content.

Budryn, G., & Nebesny, E. (2013) [3] used two extracts with high antioxidant activity were obtained from green and roasted Robusta coffee. These extracts were added (in concentrations of 0.1, 0.5 and 1%) to popular sweets rich in fat and susceptible to oxidation, such as cookies and chocolates. The extent of oxidation of the samples supplemented with antioxidants and their traditional counterparts was compared. The tested samples were stored for 12 weeks and analyzed in terms of physicochemical quality, sensory properties and texture. It was found that supplementation with the coffee extracts limited oxidative changes of fat in the stored confectionery products. It also had beneficial impact on sensory characteristics of the chocolates. The observed increase in the acid value of the fat both in cookies and chocolates did not give rise to the acidic or rancid taste. The most favourable effects were observed when the concentration of the extracts was 0.5%.

Desai *et al.* (2020) [8] reported that green coffee spent (GCS) as a food ingredient and its application in food products. About 70% of GCS was obtained after processing green coffee for Chlorogenic acid. The cookies fortified with roasted green coffee spent (RGCS) and unroasted green coffee spent (UGCS) were evaluated for physicochemical properties and food safety.The cookies formulations of RGCS had better sensory attributes such as colour and aroma. Thus, RGCS enriched with prebiotic oligosaccharide represent novel functional food supplement.

Aguilar *et al.* (2019) [1] found that intensity of specific sensory characteristics in cookies added with SCG was evaluated by 131 consumers using the just-about-right scale. Texture characteristics were not affected by SCG content. Crude fibre, fat, ash and TPC content increased with the increment of SCG in cookies (p<.01). All the cookies added with SCG were pleasant for consumers, although cookies with 17.5 g SCG /100 g were preferred (p<.05). Intensity of coffee flavour and granulosity seemed to determine its acceptance. Adding 17.5 and 25.0 g SCG/100 g in cookies allows obtaining a product acceptable for consumers, considered as dietary fibre source.

The effects of adding varying amounts (0%, 1.5%, 3%, 6%, and 12%) of the medium roasted coffee powder on the quality characteristics of rice cookies, which were prepared without wheat flour, were studied. Antioxidant activity of cookies increased with the increase in the amount of coffee powder. Antioxidant activity of the cookies added with 3% coffee powder was significantly higher than that of the cookies added with 1.5% coffee powder. As results of the sensory evaluation, the intensity of darkness, smell, bitterness, hardness of the cookies tended to increase with the increase in the amount of coffee powder. The overall acceptability of the cookies was significantly higher for the cookies containing 1.5~3% coffee powder than for the other samples. These results suggested that coffee powder (approximately 3%) can be utilized as an additive for preparing rice cookies which have simultaneously high antioxidant activity and acceptability (Seong *et al.,* 2014) [13].

Conclusion

The addition of Green coffee beans can significantly increase the nutritional properties of product by increasing the phenolic content and antioxidant properties compared to control product. Increasing amount of GCB addition resulted in increased phenolic content and antioxidant activity in value added *sev*. Thus, the present results can be further helpful in the formulation of other value added products which contains high antioxidant values. This can be important in bread as its staple food in many countries and this can be highly game changer for those who are highly health cautious. The green coffee beans products are not only targeting the whole population but also to the consumers who believe in the benefit of merging 'traditional' with pro-health food. In present scenario mainly in metro cities people are having very busy lifestyle and as sitting time of persons has increased a lot due to which physical activities have reduced drastically and specially after COVID-19 people are mainly focusing on healthy food products which are beneficial and good for health and they are certainly helpful in reducing a risk of social disease, so green coffee can be the one of them as it helps in regulating diabetes, blood pressure, prevents cardiovascular disease, obesity etc further more study is needed to estimate the health benefits of green coffee beans value added products.

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