DEVELOPMENT AND EVALUATION OF HEART HEALTHY FOOD PRODUCT FROM GREEN COFFEE EXTRACT

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Abstract
Recent investigations exhibited that the utilization of green coffee extracts created antihypertensive impacts, inhibitory impact on fat collection and body weight in mice and humans and modulation of glucose utilization. Antioxidant agents lessen circulatory strain and enhance blood vessel endothelial dysfunction in patients with hypertension. Chlorogenic acids, present in green coffee, has antioxidant potencies which improve endothelial dysfunction and reduce blood pressure. Consuming green coffee as a beverage is something which can be considered healthy as well as heart healthy. Since, the flavor it has is earthy and not appetizing; it is not preferred by many. This study was aimed to develop a heart healthy food product with green coffee extract which will mask its taste but still provide with the benefits. Many variations cookie was made with the different amount of green coffee extract. All the variations was evaluated organoleptically for different quality attributes (color, appearance, texture, taste, and odor) and overall acceptability by 20 panel members using 9 point hedonic scale. Chemical evaluation was also performed using most acceptable products. The result showed that acceptable developed products were not only low in carbohydrate, fat and sodium but rich in fibre, polyphenol as well as chlorogenic acid. Overall observations indicate that developed product is good for cardiac health.

Keywords: green coffee, heart, hypertention, chlogogenic acid, polyphenol

Received: 06.08.2019 Received in revised form: 16.10.2019 Accepted: 18.11.2019

1. INTRODUCTION

Cardiovascular disease (CVD) is the main source of death around the world, and hypertension is the most vital preventable hazard factor for CVD. Hypertension is related with no less than 7.6 million deaths for each year around the world (13.5% of all deaths) (France et al,1989). Hypertension is a noteworthy general medical issue in India and it represents 57% of all stroke deaths and 24% of all coronary illness deaths. It is assessed that a 2-mmHg decrease in blood pressure, population can reduce 1,51 000 strokes and 1,53 000 coronary illness deaths in India (Gupta et al, 2017).

Coffee, an imbuement of ground, roasted coffee beans, is accounted for to be among the most generally devoured drinks in the world. Despite the fact that coffee is praised for its fragrance and flavor, its caffeine content likely assumes a part in its popularity. The normal caffeine content of a 240ml brewed cup of coffee is 95 mg. A solitary espresso or espresso based drink (latte, cappuccino, macchiato, Americano) contains 65-85 mg and decaffeinated coffee contains around 3 mg of caffeine (on an average). Instant coffee for the most part contains less caffeine than these, with one cup containing around 30– 60 mg.(Hartley et al, 2000)

Caffeine (1,3,7-trimethylxanthine) is a purine alkaloid that occurs normally in coffee beans. At admission levels related with coffee utilization, caffeine seems to exert most of its biological effects through the antagonism of the A1 and A2 subtypes of the adenosine receptor. Adenosine is an endogenous neuro-modulator with mostly inhibitory impacts, and adenosine antagonism by caffeine brings about impacts that are by large stimulatory. Some physiological impacts related with caffeine administration include nervous system stimulation, rise in blood pressure, increasing metabolic rate, and diuresis. It is quickly and totally absorbed in the stomach and small intestines and dispersed to all tissues, including the brain (Mahmud et al, 2001).

But coffee in its raw form that is when unroasted is green in color consequently the name green coffee. Green coffee contains a noteworthy component that shows conflicting activities from caffeine, very specifically due to the presence of chlorogenic acid. They belong to the group of phenolic compounds, as they are formed from the esterification of caffeic acid and quinic acid (Adrina et al, 2008). Dietary polyphenols are essentially healthy as they feature various organic capacities like free radical scavenging activities. A relationship has been seen between polyphenol rich foods and disease prevention like coronary heart diseases, cancer, hypertension and so forth. Polyphenols are believed to enhance vascular health, bring down blood pressure, enhance endothelial working and upgrade nitric oxide status (Kazuya et al, 2005).

Processing of coffee beans involves roasting them using high temperature dry heat which brings about textural changes, flavour and aroma enhancement. But, the fact which was not known was that this method affected the biochemical properties of the world's favorite beverage. Chlorogenic acid, polyphenol present in green coffee is the main constituent which imparts the health benefits get degraded by the process of rosting.

Recent investigations exhibited that the utilization of green coffee extracts created antihypertensive impacts, inhibitory impact on fat collection and body weight in mice and humans and modulation of glucose utilization as well in humans. Blood pressure is identified with stress. Oxidant stress is elevated, and antioxidant mechanism activities are lessened in hypertensive patients. Antioxidant agents lessen circulatory strain and enhance blood vessel endothelial dysfunction in patients with hypertension. Chlorogenic acid and ferulic acid have antioxidant potencies which improve endothelial dysfunction and reduce blood pressure (Adrina et al 2008).

Consuming green coffee as a beverage is something which can be considered by individuals looking for a better alternative to regular coffee. Since, the flavor it has is earthy and not appetizing; it is not preferred by many. Hence, the idea was to incorporate it in a commonly consumed food product which will mask its taste but still provide with the benefits.

2. MATERIALS AND METHODS

Sample collection -The ingredients required to make cookies like maida (all purpose flour), butter, sugar, milk and vanilla essence was bought from local market, Kolkata, India. Instant coffee and green coffee powder procured from Amazon online shopping.

Reagents required - Bovine Serum Albumin (BSA), Biuret reagent, Anthrone reagent, Folin-Ciocalteau reagent, Gallic acid, petroleum ether, chlorogenic acid, caffine.

Preparation of green coffee extract: 2g of green coffee powder was boiled for 5-6 min in 150 ml water, cooled and filtered. The filtrate was used for product development.

Preparation of instant coffee extract: 2 g of instant coffee powder was dissolved in 150ml boiled water, cooled and filtered. The filtrate was used for product development.

Product Development

Cookie was chosen for product development. Basic ingredients and recipe is presented in Table1.

Table 1: Ingredients and amounts used in the basic recipe

Ingredients	Amount
Maida (all purpose flour)	60 g
Butter	35 g
Brown Sugar	10 g
White Sugar	10 g
Baking Soda	02 g
Milk	10 ml
Vanilla Essence	05 ml

Table 2: Variation and variation description of the products developed

Variations		*Variation description*
1	*a*	Basic recipe + 15ml instant coffee
	b	Basic recipe + 25ml instant coffee
	c	Basic recipe + 30ml instant coffee
2	*a*	Basic recipe + 15ml green coffee
	b	Basic recipe + 25ml green coffee
	c	Basic recipe + 30ml green coffee
	d	Basic recipe+ 50ml green coffee
	e	Basic recipe + 75ml green coffee
	f	Basic recipe + 100 ml green coffee
3	*a*	Basic recipe +75ml green coffee+ 5g cinnamon+ 10g flaxseeds
	b	Basic recipe + 75ml green coffee+ 5g cinnamon+ 10g walnuts
	c	Basic recipe +75ml green coffee+ 5g cinnamon + 5g flaxseeds + 5g walnuts
4	*a*	Basic recipe with 35g butter replaced with 15g apple sauce+ 10g unsalted butter+ 75ml green coffee+ 5g cinnamon+ 5g flaxseeds+ 5g walnuts
	b	Basic recipe with 30g maida replaced with 30g oats powder+15g apple sauce+10g unsalted butter +75ml green-coffee +5g cinnamon+5g flaxseeds+5g walnuts
	c	Basic recipe with 10g white sugar replaced with 2g stevia+ 30g maida replaced with 30g oats powder+ 15g apple sauce+ 10g unsalted butter+ 75ml green coffee+ 5g cinnamon+ 5g flaxseeds+5g walnuts

The butter and both the sugars were creamed together using an electric beater. Milk and vanilla essence were added. The dry ingredients were folded into the mixture. The dough was cooled into the refrigerator for 20mins. Small round balls were made and flattened and placed on a lined baking tray. The cookies were baked at 180^{o}C for 15mins in a preheated oven.

Initial variations were tried by incorporating instant coffee and green coffee. For the betterment of the product, walnuts, flax seeds and cinnamon powder were also used to make the variation as they have antioxidant property. As butter is the core ingredient of cookie, to reduce the amount of fat of the product butter was replaced with ingredients like applesauce and unsalted butter (Table 2).

Refined flour was not replaced completely as the cookies would not bind properly and give an uneven texture. Hence, half of the refined flour (30g) was replaced with oats flour since it added to the fiber content and provided complex carbohydrates (variation 5b). Lastly, the white sugar was replaced with stevia. Since stevia is extremely sweet, only 2g of it was enough to replace 15g of white sugar. (Variation 5c) The taste of the cookies was not extremely affected since the sweetness was still intact (Table 2).

Sensory Evaluation

The standard product and all the variations was evaluated organoleptically for different quality attributes (color, appearance, texture, taste, and odor) and overall acceptability by 20 panel (panel made with community people) members using 9 point hedonic scale (Wichchukita et al, 2014).

Chemical Analysis

The standard and approved products as chosen by the panel members were chemically analyzed for their moisture content, total ash, protein, fat, total carbohydrate, total phenol, sodium and potassium content, caffine and chlorogenic acid content.

Determination of moisture and ash content

Moisture content of the products was determined by drying sample in a pre-weighed crucible in a hot air oven at 130°C for two hours. Ash content of the products was determined by placing the measured amount of sample in a pre-weighed crucible in a muffle furnace at 600°C for 3 hours (Bhatt et al, 2013).

Determination of macronutrient content

Protein content of the products was estimated by Biuret method (Layne et al, 1957). Fat

content of the products was measured by using Soxhlet method (Nielsen et al, 2010). Total carbohydrate of the products was estimated by the Anthrone method (Thomas et al, 1986).

Estimation of Crude Fiber

5g of ground material was extracted with petroleum ether to remove fat. After extraction, 2 g of dried material was boiled with 200ml of sulphuric acid solution (0.3N) for 30 mins with bumping chips. It was filtered through muslin cloth. It was washed with boiling water till the washings were no longer acidic. It was boiled in 200ml of sodium hydroxide solution (0.3N) for 30 mins. It was filtered through muslin cloth again and washed with 25ml of boiling sulphuric acid solution, 150ml of water and 25ml of alcohol. The residue was removed and it was transferred to the ashing dish (pre-weighed). The residue was dried for 2hrs at 130+/- 2^0C. The dish was cooled in a desiccator, weighed and ignited for 30 mins at 600+/-15^0C. It was cooled in a desiccator and reweighed again (Nielsen et al, 2010).

Determination of Total Phenolic content

Total phenolic content was measured by Folin-Ciocalteau's method. Firstly, 0.1 mL of extract was made up to 5 mL with distilled water in a 10-mL volumetric flask, followed by addition of 0.5 mL 2 N Folin-Ciocalteau's phenol reagent. The reaction between the Folin-Ciocalteu reagent and phenolic compounds in alkaline medium results in the formation of a blue chromophore constituted by a phosphotungstic/phosphomolybdenum complex that absorbs radiation and allows quantification. Results were expressed as mg gallic acid equivalents (GAE)/100 g of fresh weight (Sagbo et al, 2017).

Estimation of Chlorogenic acid

2 g coffee was put in 100ml of 70% ethanol for extraction. For the standard solution preparation, commercial chemical standards of caffeine and chlorogenic acid were used and dissolved in 70% ethanol at 10mg/ml. UV/Vis absorption measurements were carried out on spectrophotometer in the range 200–600 nm. Absorbance was recorded for chlorogenic acid at 330 nm. For the product 2 g product was put in 100ml of 70% ethanol for extraction and follow same procedure (Navarra et al, 2017).

Determination of Sodium and Potassium

The sodium and potassium content of the product were estimated by flame photometer (Make: Elico, India. Model-CL220) An analytical reagent quality sodium chloride (NaCl) is weigh and transfers it into 1 liter volumetric flask through a funnel. Simultaneously weigh 1.909 gm of analytical reagent quality of potassium chloride (KCl) and transfer it into the same volumetric flask through the same funnel. Add double distilled water to the flask, dissolved the crystals and make up the solution to the mark with double distilled water. The stock standard solution contains 1000 ppm/1000 ppm of sodium and potassium. From this stock standard solution 100, 80, 60, 40, 20 ppm solution of lower concentration was prepared. Aspirate Distilled Water and set the read out 00 by adjusting the zero control.

Aspirate the standard solution that has higher concentration adjust the nobe to 100. For optimum performance the instrument should be allow 15 min to warm up during this warm up period a blank demonized water sample should be aspirated. Emissions were noted for all standard solution. Lastly test sample solutions were aspirated and emission was noted (Deal et al, 1954).

Statistical Analysis

The results of chemical analysis were expressed as mean ± standard deviation of triplicate analyses while mean of sensory scores for each attribute was based on twenty judgments. The results were analysed by using SPSS version 18 (IBM Corporation, SPSS Inc., Chicago, IL, USA). Microsoft word and Excel was used to generate tables**.**

3. RESULTS AND DISCUSSION

Sensory Evaluation

Acceptability of variation product/ recipe including basic were evaluated from the ratings obtained through the score card using 9 point hedonic scale during the sensory evaluation and comparative study between the products was done.(Table 3). Considering the overall rating of the product, the most accepted product from each group and basic recipe product were selected for biochemical analysis. The selected variants were, Basic recipe, Variation 1b, Variation 2e, Variation 3c, Variation 4b and Variation 4c.

Chemical analysis

Total moisture and ash content: Total moisture content and ash of the most accepted products and basic recipe were estimated (Table: 4). Result showed that, variation 4b has the highest moisture content (6.83%) and the basic recipe has the lowest content (4.85%). The increase in moisture content is due to the addition of ingredients like green coffee extract and apple sauce (replacing ½ of the amount of butter) which have added water in them. The basic recipe has the lowest moisture percent because of the absence of any water containing ingredients. Ash content is the residue left behind when a food product is subjected to high temperatures. It signifies the mineral content of the product and is hence estimated. Result showed that, variation 3c and 4c have similar percentages of ash content (1.39-1.4%) and the lowest content is found in the basic recipe sample (0.95%). The ash content can be subjected to the presence of minerals like potassium, magnesium, calcium, etc. in the green coffee bean extract. Also, walnuts and flax seeds are rich in minerals like copper and phosphorus.

Crude Fiber content

Individuals with high intakes of dietary fiber appear to be at significantly lower risk for developing coronary heart disease, stroke, hypertension, diabetes, obesity, and certain gastrointestinal diseases. Increasing fiber intake lowers blood pressure and serum cholesterol levels. Increased intake of soluble fiber improves glycemia and insulin sensitivity in non-diabetic and diabetic individuals (Trowell et al, 1973; Anderson et al, 2019).

Table 3. Table representing the Mean± S.D. of the ratings given to the different attributes of the sensory evaluation

Variation	Appearance	Color	Aroma	Texture	Taste	Overall Rating
Basic	7 ± 0.26	8.2± 1.32	8.1± 0.46	8.6± 0.15	7.9± 0.88	8.1±0.21
1a	7.4±0.64	7± 1.19	8.8± 0.12	7.4± 0.22	7.6± 0.13	7.3±0.98
1b	8.5±0.83	8.1±1.03	9.3± 0.23	8.4±0.19	8.9± 0.34	8.9±0.34
1c	7 ± 0.91	8.5±1.26	8.2± 0.35	8.7± 0.28	7.3± 0.41	8.1±0.42
2a	6.9±0.57	7.3±1.30	7.9± 0.11	7.6± 0.32	7.3± 0.59	7.2±0.17
2b	7 ± 0.98	7.2±1.11	7.6± 0.19	8.3± 0.22	7.1± 0.22	7.8±0.76
2c	7 ± 0.49	7.4±1.06	7.6± 0.41	7.4± 0.29	7.2± 0.08	7.7±0.22
2d	8 ± 0.99	8.1±1.32	7.8± 0.36	7.9± 0.11	8.1± 0.12	8.1±0.45
2e	8.1±0.96	7.4±1.27	8.3± 0.22	8.2± 0.37	8.3± 0.39	8.3±0.05
2f	8 ± 0.89	8.2±1.16	7.1± 0.45	7.6± 0.32	7.8± 0.18	8 ± 0.18
3a	8.6±0.21	8.1±1.30	8.7± 0.31	8.1± 0.36	7.8± 0.21	8±0.75
3b	8.5±0.43	7.9±1.19	8.7± 0.59	7.8± 0.78	8.8± 0.62	7.9±0.18
3c	8.8±0.35	8.2±1.26	8.8± 0.32	8.2± 0.19	8.1± 0.99	8.3±0.63
4a	7.3±0.79	8.4±1.39	8.25±0.22	7.9± 0.27	8.3± 0.12	8±0.05
4b	8.1±0.61	8.8±1.05	8.3±0.21	8.1± 0.31	8.4± 0.56	8.1±0.49
4c	7.8±0.37	7.9±1.17	8.2±0.19	8.8± 0.29	8.1± 0.39	8.4±0.58

Table 4: Moisture, ash and crude fiber content of the most acceptable products.

	Basic	Variation 1b	Variation 2e	Variation 3c	Variation 4b	Variation 4c
Moisture (%)	4.85 ± 1.2	5.61 ± 1.5	5.54 ± 1.8	5.29 ± 1.6	6.83 ± 2.2	6.02 ± 2.0
Ash (%)	0.95 ± 0.3	1.1 ± 0.2	1.23 ± 0.3	1.39 ± 0.4	1.42 ± 0.4	1.4 ± 0.42
Crude fibre (%)	0.22±0.05	0.21±0.06	0.22 ±0.04	0.78 ±0.07	1.02 ±0.08	1.4 ± 0.08

Crude fiber is a type of dietary fiber that remains after digestion from dilute acid and alkali. From Table 4 it can be concluded that, variations 3c, 4b and 4c have a slightly high amount of crude fiber content (1.4%) whereas the basic recipe, variations 1b and 2e have the lowest (0.21-0.22%). The slight increase in the amount of crude fiber can be accounted to the addition of walnuts, flax seeds and oats powder which have good fiber content. The basic recipe, variations 1b and 2e are made of refined flour which has very less amount of fiber (Table 4).

Total Macronutrient content

Protein, carbohydrate and fat content of the most accepted product including basic recipe were estimated. It was found that the protein content of the basic and most acceptable product did not show much change. The high fat content in variation 3c is subjected to the addition of walnuts and flaxseeds in the cookies which provide polyunsaturated fatty acids. In variation 4b and 4c half the amount of butter has been replaced with applesauce may be the reason for the decrease in fat content. The low carbohydrate contents in variation 4b (67.5g/100g) and variation 4c (45.1g/100g) may be due to the replacement of refined flour with oats powder and white sugar with stevia respectively. Protein, carbohydrate and fat content (g/100g) of products were represented in Fig 1.

Sodium and potassium estimation

In almost every country that has established guidelines for the prevention and treatment of cardiovascular disease (CVD) and stroke. National health agencies and professional societies recommend a reduction in dietary sodium as a means to lower blood pressure (BP) and to prevent CVD and stroke.

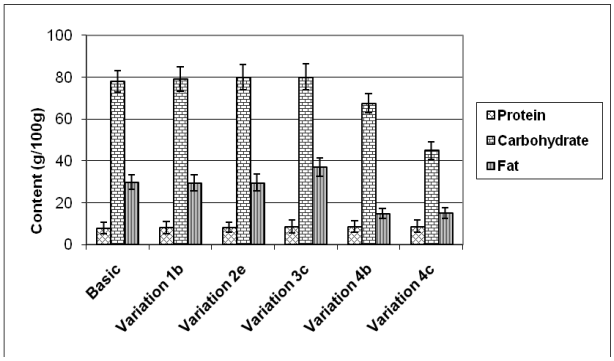

Fig 1: Macronutrient content of the most accepted product

Excess sodium intake has been shown to increase BP and to cause adverse cardiovascular effects in humans and several species of experimental animals. Conversely, dietary potassium attenuates these effects showing a linkage to reduction in stroke rates and cardiovascular disease risk (Whelton et al, 2012). Different clinical trial concluded that reduced intake of sodium and increased intake of potassium could make an important contribution to the prevention of hypertension, especially in populations with elevated blood pressure (Grobbee et al, 2003).Results showed that concentration of sodium in basic recipe, variation 1b, variation, 2e is almost same where concentration of sodium at variation 4c and variation 4b much lower. Potassium conc. is relatively close in all samples (Fig. 2).

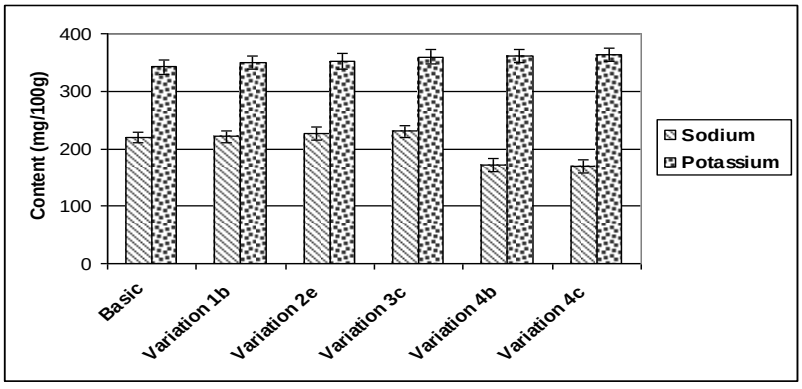

Fig. 2. Amount of sodium and potassium in the most accepted product

Total Polyphenolic Content

Polyphenols are secondary metabolites of plants and are generally involved in defense against ultraviolet radiation or aggression by pathogens. Epidemiological studies have repeatedly shown an inverse association between the risk of chronic human diseases and the consumption of polyphenolic rich diet . Number of studies has demonstrated that consumption of polyphenols limits the incidence of coronary heart diseases (Omaye et al, 2001). Polyphenols are potent inhibitors of LDL oxidation and this type of oxidation is considered to be a key mechanism in development of atherosclerosis (Fuhrman et al, 2000). Other mechanisms by which polyphenols may be protective against cardiovascular diseases are antioxidant, anti-platelet, anti-inflammatory effects as well as increasing HDL, and improving endothelial function. Polyphenols may also contribute to stabilization of the atheroma plaque. Polyphenols also can stimulate vasodilation by promotimg the formation of vasoprotective factors like nitric oxide and endothelium derived hyperpolarizing factor which improves vascular smooth muscle functiong and reduces vascular tension thus improving blood pressure (Jiang et al, 2010).

Polyphenols are secondary metabolites found in plants that greatly benefit due to their antioxidative properties, total polyphenol content was found to be high in variations 3c (406mg/100g), 4b (401mg/100g) and 4c (398mg/100g) and lowest in the basic recipe. Higher polyphenolic activity due to presence of higher concentration of chlorogenic acids. Further increase can be accounted to the addition of walnuts, flax seeds and cinnamon powder in variation 3c which also consist of polyphenols and exhibit antioxidative protection (Fig. 3).

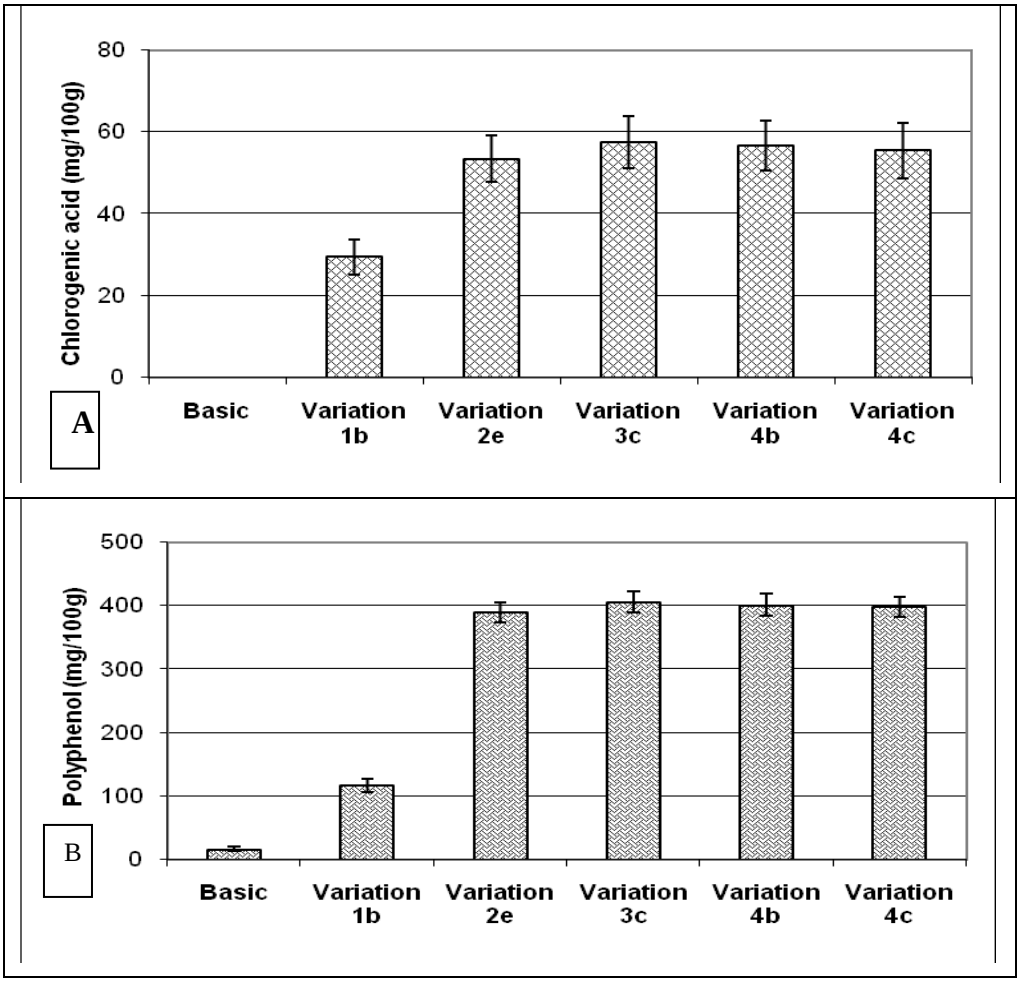

Fig. 3. Amount of chlorogenic acid (A) and polyphenol (B) content of the most accepted product

Chlorogenic acid estimation

Chlorogenic acids (CGAs) are dietary polyphenol and potent antioxidants found in certain foods and drinks, most notably in coffee. In recent years, basic and clinical investigations have implied that the consumption of chlorogenic acid can have an anti-hypertension effect. Mechanistically, the metabolites of CGAs attenuate oxidative stress (reactive oxygen species), which leads to the benefit of blood-pressure reduction through improved endothelial function and nitric oxide bioavailability in the arterial vasculature. In a randomized, double-blind placebo-controlled study, 117 untreated patients with mild hypertension were assigned to four groups to receive 180 ml of fluid containing 0 (placebo), 46, 93 or 185mg of GCE with 54% CGA content. After consumption of GCE for 28 days, SBP and diastolic blood pressure (DBP) were reduced in a dose-dependent manner by 1.3/0.8, 3.2/2.9, 4.7/3.2 and 5.6/3.9mmHg, respectively (Zhang et al 1912). In another randomized, double-blind placebo-controlled clinical trial, when 480mg per day of GCE (equivalent to 140mg per day CGA) was given in a mixture of fruit and vegetable juice, SBP/DBP in the CGA-treated group decreased significantly by 8/7mmHg at week 4 and by 10/7mmHg at week 12 from baseline (Saito et al 2006).

Chlorogenic acid was estimated by scanning UV/Vis absorbance spectra within the wavelength 200 nm to 400 nm. It was found that green coffee products have much higher concentration of chlorogenic acid compared to the instant coffee product (Fig. 3).

4. CONCLUSIONS

An attempt has been made in this study to produce a food product (cookie) by incorporating green coffee extract to utilize the benefit of chlorogenic acid, a dietary polyphenol present in green coffee. It is evident form the result that well accepted developed products are rich in chlorogenic acid as well as polyphenol, which can reduce the risk of chronic human diseases including coronary heart diseases, hypertension etc. In addition to this to make the product more healthy carbohydrate content was reduced by replacing maida with oats and white sugar with stevia (variation 4b & 4c). Sodium content of the product was also decreased by using unsalted butter and fat content reduced by replacing 50% of the butter with apple sauce (variation 4b & 4c). Altogether, it can be concluded that developed products can be used as healthy snacks, which is not only rich in chloregenic acid but also low in sodium, carbohydrate and fat (specially variation 4b & 4c). Overall, the developed products are good for cardiac health.

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