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FULL PAPER

Physicochemical, antioxidant and sensory characteristics of cookies supplemented with different levels of spent coffee ground extract

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Abstract

Spent coffee grounds (SCG) are the primary by-product of coffee production which still contains functional properties with high natural antioxidant components. It can be extracted using ultrasonic-assisted techniques and then integrated into baking products such as cookies. This research is aimed to measure the physicochemical and sensory acceptability of cookies incorporated with SCG extract. Extraction of SCG was done using water through ultrasonic extraction following incorporated SCG water extract into cookies. Six different formulations were developed using different amount of SCG extract (A-control 0%, B-0.27%, C-0.52%, D-0.80%, E-1.07% and F-1.33%). Physicochemical properties (antioxidant properties, colour profile, texture, moisture, sugar, fat, protein, ash, calorie and texture profile) and the sensory acceptability of SCG extract cookies was observed. Total phenolic content (TPC) was used to quantify the antioxidant content while the antioxidant activity was measured using 2,2-diphenyl-2-picrylydrazyl radical scavenging activity assay (DPPH) and ferric reducing antioxidant power (FRAP) assays. Results show that decreasing in lightness (L*) and yellowness (b*) with the increasing percentage of SCG extract were observed. In contrast with L* and a* value, the b* value of cookies was increased with the increasing percentage of SCG extract. Formulation E (1.07% SCG extract) showed the highest percentage in almost all proximate analysis such as 6.49±0.39 moisture, 2.11±0.22 ash, 20.42±0.74 crude fat, 8.13±0.05 crude protein and 4.37±0.04 crude fibre content. The highest amount of antioxidant content was depicted by the formulation D cookie (1.72±0.04 mg GAE/g). The best antioxidative activity was found in formulation E (7.80±0.27 DPPH inhibition and 0.02 abs by FRAP analysis). Sensory acceptance revealed that formulation E (1.33%) cookies were more accepted by the panellists. It is interesting to note that SCG can serve as one of the ingredients for cookie production that showed significant effects on the physicochemical and organoleptic properties of the final products.

1. Introduction

Global coffee production has increased by 6% since 2010 and a total of 9.6 million tons of coffee bags were made in 2019 (ICO, 2020). The increase in the amount of coffee brewing, the amount of coffee spent, hereinafter referred to as Spent Coffee Ground (SCG), has increased accordingly. SCG is one of the most abundant by-products produced by the food industry worldwide (López-Barrera *et al*., 2016). Such biomass residues are greatly underutilized, even though they are generated in increasingly larger amounts, with most of the residues being discarded in landfills or used, albeit to a very small extent, in composting (Liu and Price, 2011; Valipour, 2015). SCG is regarded as a good raw product for the recovery of bioactive compounds. SCG extracts are also rich in antioxidants, especially chlorogenic acid (5-caffeoylquinic acid) and melanoidine, which are capable of preventing serious neurodegenerative and cardiac diseases (Pettinato *et al*., 2017). The need for an

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effective extraction method for extracting spent coffee ground to be applied to bakery products.

Ultrasound-assisted extraction (UAE) is an effective extraction process that can produce high concentrations of bioactive compounds with a shorter extraction time (Prakash *et al*., 2017). Furthermore, Chemat *et al*. (2017) reported that experiments supported with ultrasound have shown that extraction is a green and economically viable alternative to traditional food and natural product techniques. The main benefits of using UAE are decreased extraction and processing time, the amount of energy and solvents used in unit operations and CO_2 emissions. A strong SCG extract could be extracted using the UAE process and could be used as an antioxidant by mixing it in bakery products such as cookies (Ali *et al*., 2018).

Cookies have become one of the most common foods for both young and elderly people due to lack of demand, improved convenience, long shelf life and the ability to serve as a source of important nutrients (Akubor, 2003). Cookies are small-scale baking products (Manley, 1998) made of a mixture high in sugar and fat and relatively low in water (Hoseney, 1986). Manley (1998) described cookies as products made from wheat flour, fat, milk powder, salt, sugar, water and some minor ingredients such as sodium bicarbonate, ammonium bicarbonate and emulsifiers that improve colour, taste, texture and consistency. These are characterized by a well-developed gluten structure, but with the amount of sugar, fat and gluten, these become more extensible and less versatile (Pereira *et al*., 2013). Cookies are a potential candidate for the addition of SCG as a functional ingredient because they are a popular bakery item and are consumed by nearly all levels of society in both developed and developing nations (Olagunju, 2014). The popularity of cookies may be related to their good taste, variety, low cost and convenience (Handa *et al*., 2011; Laguna *et al*., 2011). There is a knowledge gap in the use of SCG to enhance the nutritional quality of bakery items, such as cookies. The use of SCG containing bioactive compounds which will enrich nutritionally cookies is therefore of great importance. Therefore, the purpose of this paper is to investigate the impact of the inclusion of spent coffee ground extract on physicochemical quality in cookies, such as physical characteristics, texture profile, proximate assessment, antioxidant properties and sensory acceptability, in order to fully understand potential information gaps utilization of SCG.

2. Materials and methods

2.1 Materials

The raw materials needed for the study was the coffee ground with Arabica type which were purchased from Kilang Kopi FAMA Banting (Selangor, Malaysia). The coffee beans were fully processed by the coffee farmers at the factory.

2.2 Preparation of SCG

The coffee brews were prepared as described by Bravo *et al*. (2012) with some modifications. Coffee beans were grounded using a grinder for 1 min with 10 s intervals. The coffee was brewed using a French Press coffee maker with 100 g of ground roasted coffee, which was extracted by adding 500 mL of water at 98°C into the plunger brewer. The coffee powder and the water kept in contact for 5 mins before the plunger is slowly pushed down. The SCG was collected, drained and dried using an oven at 40°C until for 25 hrs and stored at -18° C.

2.3 Ultrasonic-assisted extraction

SCG of 20 g was diluted in 200 mL water and immersed in an ultrasonic water bath (UC-10, JEIO Tech -Korea) at 50 kHz, 400 W, and the temperature was set at 40°C for 1 hr. After the three times extraction, the SCG was filtered using a vacuum pump. The SCG extract was concentrated by drying at 60°C using the drying cabinet. The extracted sample was stored in amber bottles at -18°C (Zainol *et al*., 2018).

2.4 Production of cookies

Cookies were produced according to the method described by (Aly and Seleem, 2015) with some modifications. The modified recipe adopted after preliminary experimentation was as follows: margarine (150 g), castor sugar (52.5 g), salt 0.75 g), eggs (25 g), wheat flour (113 g) and baking soda (3 g) (Table 1). The margarine and castor sugar were beaten using speed 1 for 2 mins, the egg and milk powder were added during mixing. The baked cookies were cooled to room temperature and packed in airtight containers for further analysis.

2.5 Dimensions

The thickness of cookies was determined by measuring the diameter of four cookies samples placed edge to edge with a digital vernier calliper. An average of three values was taken for each set of samples. The average value for thickness was reported in millimetres (mm). The diameter of cookies was determined by placing four biscuit samples edge to edge and measuring with a digital vernier calliper. An average of three values was taken for each set of samples. The average value for diameter was reported in millimetres. The weight of cookies was measured as average values of six individual cookies with the help of an analytical weighing balance

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Table 1. Ingredients used in different formulations for preparation of SCG cookies

Ingredients (g)	Control	A (0.27%)	B (0.53%)	C (0.80%)	D (1.07%)	E (1.33%)
Wheat flour	26.63	26.63	26.63	26.63	26.63	26.63
Pastry flour	26.63	26.36	26.09	25.83	25.57	25.3
Sugar	18.64	18.64	18.64	18.64	18.64	18.64
Margarine	21.3	21.3	21.3	21.3	21.3	21.3
Milk powder	5.33	5.33	5.33	5.33	5.33	5.33
Baking powder	1.07	1.07	1.07	1.07	1.07	1.07
Salt	0.13	0.13	0.13	0.13	0.13	0.13
Egg	0.27	0.27	0.27	0.27	0.27	0.27
SCG extract	0	0.27	0.53	0.8	1.07	1.33

(Bala *et al*., 2015).

2.6 Colour profile analysis

The colour intensity of the top and down (the one in contact with the baking tray) surfaces of cookie samples were measured using a Konica Minolta Colour Measuring System (Chroma Meter CR-410, Minolta LTD Japan). The lightness (L*), redness (a*), and yellowness (b*) values were obtained after calibrating the instrument using a white tile. Triplicate readings were taken for each cookie formulation sample.

2.7 Cookie texture

The instrumental texture measurements were made with a TA.XT.Plus texture analyzer (Stable Microsystems, UK). The hardness, springiness, chewiness and gumminess of the pastilles product were determined by this assessment. A force-time graph was produced and textural parameters such as hardness, springiness, chewiness and gumminess were acquired with the assistance of the software supplied with the instrument.

2.8 Aqueous extract of cookies

Aqueous extracts of the cookies were prepared by soaking 10 g of the milled biscuits in 100 mL of distilled water for 24 hrs at 37°C; the mixtures were filtered, centrifuged and supernatants were stored in the refrigerator for subsequent analysis (Oboh *et al*., 2010).

2.9 Chemical analysis

Proximate analysis was conducted to determine the percentage of moisture, ash, crude protein, crude fat, and crude fibre, according to the Association of Official Analytical Chemists' procedure (AOAC, 2007). The calorie content in the cookie extract sample was determined using a bomb calorimeter. The sample was put in the crucible in the combustion chamber for the combustion process. After the combustion complete, the heat of combustion (cal/g), the change in temperature was noted on the screen. The bomb was opened and the remaining fuse wire was observed and the weight and its length were measured.

2.10 Total phenolic content

The total phenolic content (TPC) of SCG cookie extracts was determined spectrophotometrically using Folin-Ciocalteu reagent (Zainol *et al*., 2017). Gallic acid was used as a standard and results were expressed in mg of gallic acid equivalents (GAE) per g of sample on a dry mass basis. Approximately 4 mL of SCG extract was mixed with 2 mL of sodium carbonate solution at 7.5% (w/v) and 7.5 mL of 10% Folin-Ciocalteu reagent. The mixtures were let to stand at room temperature for 1 hr. The absorbance was measured by using a spectrophotometer at 760 nm.

2.11 Antioxidant capacity using 2,2-diphenyl-2-picrylydrazyl (DPPH) radical scavenging activity assay

The DPPH was conducted according to the procedure as described by Malik *et al*. (2017) with some modifications. Four milligrams of cookie sample was dissolved in 1 mL methanol and assayed in triplicate. BHT and ascorbic acid were used as standards. 3.0 mL of 0.1 Mm methanol DPPH was added and vortex well. The test tubes were allowed to stand at room temperature in the dark for 1 hr. The reduction of the DPPH free radical in the cookie sample was measured by reading the absorbance at 517 nm.

2.12 Sensory evaluation

A sensory evaluation session was conducted based on a 7-point hedonic scale where a higher score indicates better quality attributes (1, dislike very much and 7, like very much) (Mamat *et al*., 2018). Sensory attributes such as colour, aroma, appearance, crispiness and flavour of biscuit were evaluated. Each attribute was independently judged by forty untrained panels based on their likeness. The sample was packed and coded with a 3-digit code. The coded samples were served in a tray to the panellist (Lawless and Heymann, 2010). The random permutation principle was followed to determine the serving order. The judges evaluated randomLy coded cookies in terms

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of colour, appearance, flavour, texture, taste and overall acceptability.

2.13 Statistical analysis

The data was collected and analysed using ANOVA and Fisher's multiple range tests the significant difference ($p<0.05$) data were further analysed and $p<0.05$ were regarded as significant. The data were analysed using Minitab 14 software and all data obtained were presented at mean ± standard deviation.

3. Results and discussion

3.1 Production of cookies

Variations in the percentage of SCG extract incorporated may or may not substantially (at $p<0.05$) affect these attributes of cookies. Formulation D and E obtained the highest average weight, while formulation A was the lowest (Table 2). The increasing percentage of SCG extract incorporated cookies showed an increasing value in the weight of cookies. The variety of weight for all the formulation may be due to an increasing percentage of SCG extract incorporated and the shaping technique of cookie with cutting the dough before baking. Petrovic *et al*. (2016) observed that the addition of cherry pomace extract resulted in cookies with the weight that was significantly different from that of the control cookie. It was probable that the addition of the cherry pomace extract would increase water retention in flours. So, the increased water retention in flours with the SCG extract addition also may contribute to the increase in weight of the cookies. Table 3 illustrates the diameter of the SCG cookies and the control cookie. The control cookie has the highest thickness of 8.20 mm and formulation E exhibited the lowest thickness (5.91 mm). The increasing percentage of SCG added cookies showed a decreasing value in the diameter and thickness of the cookies. Petrovic *et al*. (2016) suggested that the diameter of the cookies decreased when the extract was replaced and, therefore, the cookies were distinguished by a higher thickness of the cookies. Supplementation with SCGs resulted in cookies being produced with significantly greater weight compared to control. Strikingly, as the amount of SCG in the cookie increased, the diameter and thickness decreased significantly compared with the control.

3.2 Colour profile analysis

The decrease in lightness (L *) was attributed to the less light dispersion by increasing the percentage of the dark SCGs extract (Table 3). The a* value of biscuits increased with an increased mixing amount of SCGs extract, where a* value was 0.45 in the control sample, then significantly increased with an increase in the percentage of SCG extract into cookies. In contrary with a* value, b* value of the cookie with SCGs extract decreased significantly. Colour attributes are affected mainly by the degree of browning during baking (Hussein *et al*., 2019). At the start of non-enzymatic browning caused by the interaction of proteins or amino acids and sugars, an increase in a * and b * could be observed due to the increase in redness and yellowness. The colour of the cookies changed from creamy yellow to dark brown, as the SCG extract incorporation increased. That may be because of the browning reactions that occur during baking. Maillard browning and caramelization of sugar during baking is considered to create brown pigments (Laguna *et al*., 2011). Petrovic *et al.* (2016) reported that the addition of cherry pomace extract favours the development of colour cookies due to the high sugar and protein content that contributed to Maillard reactions, resulting in a decrease in lightness (L* value) with the increasing extract level. At the same time, a positive a* values (redness) in cookies increased because of characteristic anthocyanin structure (Patras *et al*., 2010). The colour of the SCG extract may influence the colour of the cookie. Krystyjan *et al*. (2015) indicated that the inclusion of bee pollen in the biscuit surface caused darkening, however, in this study, it was not possible to observe any difference between samples (with or without SCG extract), that could be considered a positive feature if it is intended to preserve the traditional

Table 2. Different dimensions of the SCG cookies prepared by different formulations.

Formulation	Weight (g)	Diameter (mm)	Thickness (mm)
Control	3.25±0.19^{b}	31.95±0.07^{a}	8.20±0.14^{a}
A (0.27%)	3.23±0.14^{b}	31.35±0.21^{a}	8.15±0.21^{a}
B (0.53%)	3.45±0.05^{ab}	30.75±1.34^{ab}	7.15±0.21^{b}
C (0.80%)	3.46±0.06^{ab}	30.60±1.56^{ab}	6.22±0.40^{c}
D (1.07%)	3.51±0.01^{a}	30.80±0.00^{ab}	6.10±0.00^{c}
E (1.33%)	3.51±0.04^{a}	29.05±0.21^{b}	5.91±0.30^{c}

Values represent the mean ± standard deviation. Values with the same superscript letters in the same row are not significantly different (P>0.05).

Table 3. Colour profile analysis of the SCG cookies prepared by different formulations.

Samples	L*	a*	b*
Control	77.30±0.20^{a}	0.45±0.21^{d}	35.92±0.06^{a}
A (0.27%)	73.16±0.46^{b}	3.36±0.92^{c}	33.88±0.93^{ab}
B (0.53%)	71.66±0.94^{bc}	3.69±0.90^{c}	32.91±0.91^{bc}
C (0.80%)	69.94±1.92^{c}	3.31±0.90^{c}	30.75±2.71^{cd}
D (1.07%)	67.54±1.87^{d}	5.74±1.14^{b}	30.07±0.35^{d}
E (1.33%)	61.07±0.78^{e}	7.70±0.80^{a}	24.88±0.67^{e}

Values represent the mean ± standard deviation. Values with the same superscript letters in the same row are not significantly different (P>0.05).

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nature of cookies.

3.3 Cookie texture profile analysis

Hardness can be defined as a force necessary to attain a given deformation (Szczesniak, 2002). Table 4 shows that there is no significant difference (p>0.05) between the cookies. The hardness of the cookies is generally increased from control cookie to formulation C with 0.80% of SCG extract incorporated (65.30±6.36 g to 75.50±3.68 g) and slightly lower in formulation D and E with 1.07 and 1.33% of SCG extract incorporated (67.60±0.00 g and 67.10±1.56 g). The control cookie exhibited the least hardness value. The differences observed might be caused by the structure of the cookies in addition to ingredients used which might generate large force fluctuations (Kontogiorgos, 2010). Formulation C (0.80%) shows the highest hardness value with 75.50±3.68 g. Cookies with SCG extract incorporated and less flour used had higher hardness value compared to the control cookie with no SCG extract incorporated and more flour used.

Table 4. Texture profile analysis of the SCG cookies prepared by different formulations

Samples	Hardness (g) force^{-1}	Fracturability (mm) distance $^{-1}$
Control	65.30 ± 6.36^{a}	37.70 ± 1.53^{c}
A (0.27%)	69.15 ± 7.28^{a}	38.43 ± 1.09^{bc}
B (0.53%)	70.60 ± 4.24^{a}	39.90 ± 0.15^{a}
C (0.80%)	75.50 ± 3.68^{a}	39.04 ± 0.66^{b}
D (1.07%)	67.60 ± 0.00^{a}	39.25 ± 0.71^{ab}
E (1.33%)	67.10 ± 1.56^{a}	40.03 ± 0.12^{a}

Values represent the mean ± standard deviation. Values with the same superscript letters in the same row are not significantly different (P>0.05).

Fracturability is the measurement of cookie resistance of bending. The distance at which the cookie breaks was noted as fracturability. Cookies that break at a shorter distance has higher fracturability (Anis Jauharah *et al*., 2014). Baked biscuits are most often tender and crunchy because little or no gelatinization of starch and sugar is produced (Penfield and Campbell, 1990). Analysis of variances showed that the product thickness had a significant effect (p<0.05) on fracturability and the maximum value was observed at formulation E (1.33%) with 40.03 ± 0.12 mm, while minimum value of 38.43 ± 1.09 mm was observed at the thickest cookie which was the control cookie. Control cookie showed the lowest distance value which indicated that it had higher fracturability among all cookies. Similar to Adeola and Ohizua (2018), who found that the fracturability of the biscuit samples significantly decreased (p < 0.05) as the level of UBF increased, where the increasing percentage of SCG extract incorporated reduced cookie fracturability.

3.4 Chemical analysis of the SCG cookies

Table 5 shows the gradual increment in moisture content in control cookie and SCG extracts incorporated cookies, which could be due to the consistency of baking temperature and time since it was the same baking condition that was used for all. This probably influenced the lower hardness of these biscuits, as the water molecules being present in the food matrix possibly caused a softening and softening of the structure. The ash content of SCG cookies was higher than the control, indicating that with the incorporation of SCG extract contributed to ash content in the SCG cookies. Ash content of SCGs is in concordance with a previous study conducted by Mussatto *et al*. (2011) who found that a low ash content in SCGs suggested that brewing conditions during industrial coffee extraction result in enormous loss of minerals and ash. Interestingly, there are no variations observed in the fat contents of the SCG cookie samples because of the same quantity of fat used in the recipe. However, the fat content of SCG extracts incorporated cookies were slightly higher than the control. This showed a slight increase in fat content when SCG extract added to cookies. In protein analysis, there were some variations between all the cookies formulation, yet no significant difference (p>0.05) was observed between formulation C, D and E cookies. The cookies showed increases in protein content when the percentage of SCG extract increased. The increasing addition of SCGs has shown good enhancement in protein in cookies when compared to the control cookie. Such increment revealed the thermal stability of SCGs during food processing, which makes them safe and suitable to be incorporated into food products. Martinez-Saez *et al*. (2017) produced biscuits supplemented with many functional ingredients such as maltitol, oligofructose, stevia and SCGs. However, they were focused more on digestibility, safety, and sensory properties for the innovated biscuits without clear complete data concerning the chemical composition of the final product (Martinez-Saez *et al*. 2017). The crude fibre content of the cookies varied from 2.72±0.53% to 4.51±0.02%. The increasing addition of SCG also gives good enhancement in crude fibre compared to the control cookie. Ali *et al*. (2018) mentioned that increasing the addition of SCGs (2, 4 and 6%) has shown good enhancement in fibre and ashes in nutraceutical biscuits when compared to control. Gradual decrement of carbohydrate content was observed for control cookie and SCG extracts incorporated cookies. The SCG extract incorporated cookies showed lower scores for carbohydrates than control cookies. Table 5 also depicts

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Table 5. Proximate composition and calorie content of the SCG cookies prepared by different formulations.

Chemical Analysis	Control	A (0.27%)	B (0.57%)	C (0.80%)	D (1.07%)	E (1.33%)
Moisture	5.54±1.03[a]	5.47±0.58[a]	5.24±0.36[a]	5.37±0.17[a]	5.48±0.23[a]	6.49±0.39[a]
Ash	0.76±0.69[b]	1.77±0.26[a]	1.70±0.12[a]	2.26±0.12[a]	1.88±0.05[a]	2.11±0.22[a]
Protein	5.53±0.05[bc]	5.09±0.21[c]	7.21±1.89[ab]	8.33±0.20[a]	8.08±0.24[a]	8.13±0.05[a]
Fat	16.56±3.89[a]	18.97±0.37[a]	18.95±0.16[a]	19.00±0.95[a]	19.62±0.38[a]	20.42±0.74[a]
Fibre	2.72±0.53[b]	2.93±0.28[b]	3.90±0.11[a]	3.96±0.24[a]	4.51±0.02[a]	4.37±0.04[a]
Carbohydrates	68.89±0.53[a]	65.77±0.28[a]	63.00±0.11[b]	61.08±0.24[bc]	60.43±0.02[bc]	58.48±0.04[c]
Calorie (kcal/g)	482.00±0.11[b]	501.54±0.01[a]	503.89±0.01[a]	502.34±0.01[a]	511.17±0.08[a]	509.64±0.01[a]

Values represent the mean ± standard deviation. Values with the same superscript letters in the same row are not significantly different (P>0.05).

the carbohydrate content of the cookies decreased as the protein content increased where SCG extract showed good enhancement in protein. These findings are in agreement with previous studies conducted by (Olagunju, 2014) where the carbohydrate content of the biscuits made from wheat flour and germinated sesame flour blends decreased when the protein content of the biscuits increased. Statistically, there was no significant difference (p>0.05) for calorie content between the cookie samples. For the calorie content, the highest calorie content was observed in the formulation D cookie with 1.07% of SCG extract incorporated. The energy content of the cookie samples increased as the protein content increased. This was in concert with the study by Adeola and Ohizua (2018) where the energy content of the biscuit samples also increased as the protein content increased.

3.5 Total phenolic content of the SCG cookies

Phenolics are generally bound with cell wall structural proteins and carbohydrates (Parmar *et al*., 2017) and might get released by rupture of cell wall upon heating resulting in the increase in TPC of cookies. TPC of cookies might also be enhanced due to the generation of Malanoidins produced in the Maillard reaction at high temperatures (Bhat *et al*., 2018). Total phenolic content (TPC) of control and SCG cookies were presented in Table 6. Baking of cookies was found to be significantly (p<0.05) affected their total phenolic content and was found in the range of 0.76 - 1.72 mg GAE/g. The SCG cookies were significantly higher compared to that of the control cookie, yet, there was no significant difference (p>0.05) between SCG cookies. TPC increased from control cookie until formulation E (1.07%) but decreased at formulation E with the highest SCG extract incorporated cookie of 1.33%. It may be supposed that during kneading, phenols of the SCG extract bind to dough components, such as proteins, and cannot be completely recovered (Dordoni *et al*., 2019). However, it cannot be excluded that TPC was oxidized, as polyphenol oxidase enzymes are abundant in whole wheat meals (Taranto *et al*., 2012). For instance, an increase in free phenolic compounds due to degradation of conjugated polyphenolic compounds is reported by Abdel-Aal and Rabalski (2013) in whole grain bakery products. A similar increase in polyphenolic compounds was observed in biscuits supplemented with Bambara groundnut and orange peel when compared to 100% whole wheat biscuits (Adefegha and Oboh, 2013). Hence, the observed increase in phenolic compounds of the cookies in this study could be attributed to the different percentages of SCG extract that was incorporated.

3.6 Antioxidative capacity analysis using 2,2-diphenyl-2-picrylydrazyl (DPPH) radical scavenging activity assay of the SCG cookies

The DPPH radical scavenging activities of aqueous extracts of cookies are shown in Table 6. The cookies containing SCG exhibited better DPPH radical scavenging activity to that the control cookie while the highest DPPH radical scavenging activity was observed in the formulation E cookie. Formulation E with the highest TPC exhibited the highest DPPH radical scavenging activity whereas; lowest DPPH radical scavenging activity was recorded for control cookie with lowest polyphenol content. This data showed that there is a positive relationship between the polyphenolic content and DPPH radical scavenging activity of the biscuits. Pereira *et al*. (2016) stated that the different extraction methods and the solvent is chosen to be used can influence the antioxidant potential exhibited by the samples. Sharma *et al*. (2012) reported the production of dark brown coloured pigments during the thermal processing of foods due to the Maillard reaction. The increase in DPPH scavenging activity may, therefore, be attributed to Maillard reaction products (melanoidin) which improved the antioxidant activity of cookies. An increase in antioxidant activity upon thermal processing has also been reported by Sharma and Gujral (2011).

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Table 6. Total phenolic content and DPPH inhibition of the SCG cookies prepared by different formulations.

Samples	TPC (abs value)	DPPH (inhibition %)
Control	0.76±0.10^{c}	2.56±1.49^{c}
A (0.27%)	1.24±0.06^{b}	3.39±4.04^{b}
B (0.53%)	1.36±0.16^{b}	3.69±0.96^{c}
C (0.80%)	1.26±0.02^{b}	4.14±0.74^{c}
D (1.07%)	1.72±0.04^{a}	5.15±2.71^{ab}
E (1.33%)	1.44±0.08^{b}	6.62±4.47^{c}
Ascorbic acid		7.80±0.27^{a}
BHT		7.68±0.16^{a}

Values represent the mean ± standard deviation. Values with the same superscript letters in the same row are not significantly different (P>0.05).

3.7 Sensory evaluation of the SCG cookies

Table 7 reveals the sensory attributes of cookies incorporated with SCG extract and control cookie. The score for the appearance of a control cookie and SCG extract incorporated cookies were not significantly different (p>0.05). However, the control cookie showed the highest colour acceptance with a 6.00±1.11 mean score by the panellist followed by B, C, E, D and A. This showed that appearance for all the formulations was acceptable by the panellists. The colour attribute of formulation B (0.53% of SCG extract incorporated) showed the highest colour acceptance with 5.63 mean score by the panellist followed by C, E, D, control and A. This showed that appearance for all the formulations was acceptable by the panellists. As compared to the colour profile analysis in Table 3, formulation B (0.53%) had the third-highest L* value (lightness) among all the biscuits which indicated formulation B had slightly dark colour compared to the control and formulation A (0.27%) cookies. Thus, formulation B cookie colour was the most acceptable by the panellists. Statistically, for odour and taste properties, there were some differences but not significantly different (p>0.05). This is probably because, during coffee brewing, most of the volatile aromatic compounds were lost or extracted with the aqueous phase; reducing the amount of aromatics in the SCG (Martinez-Saez *et al*., 2017). Furthermore, the odour and taste acceptability were affected by the presence of more glycaemic reduced sugars, obviously because of characters such as roasted, sweet and caramel, which are perceived as the main and very positive sensory attributes (Hussein *et al*., 2019). There was no significant difference (p>0.05) were observed between the control cookie and SCG extract incorporated cookies but the control cookie showed the highest mean score with 5.57±1.25. Surprisingly, the data showed the opposite finding with the texture profile analysis where the increase of SCG extracts incorporated into cookies, the hardness value was increased. The texture of supplemented samples seems to be near as the control or better than it, which could be due to the excellent emulsifying activity and emulsion stability of SCGs reported previously by (Ballesteros *et al*., 2014).

4. Conclusion

This work provides a new perspective on using SCG as a key ingredient in the production of food. The use of SCG as one of the ingredients for the development of cookies showed significant impacts on the final products physicochemical and organoleptic properties. Formulation C cookies (0.72% of SCG extract) had the highest hardness value and formulation A with the lowest percentage of SCG extract incorporated showed the highest fracturability. The SCG extract incorporated cookies had higher fibre, protein, fat and ash content than that of the control cookies. The formulation F SCG cookies (1.33% of SCG extract) also exhibited very promising readings in TPC, DPPH and FRAP analysis. Sensory acceptance revealed that formulation E cookies (1.2% SCG extract) were more accepted by the panellists. Therefore, the addition of SCG in cookies improved quality by increasing the content of nutrients (proteins), polyphenolic substances and increased antioxidants power. Considering this finding, SCG based cookies can be a good source of antioxidant and the possibility of utilizing SCG extract into cookies and any other pastry to improve nutritionally and antioxidant properties for people consumption.

Table 7. Sensory evaluation of the SCG cookies prepared by different formulations.

Formulation	Appearance	Colour	Odour	Hardness	Taste	Overall acceptability
Control	6.00±1.11^{a}	5.33±1.27^{a}	4.03±1.77^{e}	5.57±1.25^{a}	3.70±1.49^{d}	5.03±1.40^{b}
A (0.24%)	5.50±1.41^{a}	5.20±1.38^{a}	4.57±1.52^{de}	5.47±1.31^{a}	4.10±1.56^{cd}	4.87±1.17^{b}
B (0.48%)	5.83±1.12^{a}	5.63±1.19^{a}	5.33±1.27^{bc}	5.50±1.23^{a}	4.67±1.45^{bc}	5.40±1.07^{ab}
C (0.72%)	5.73±1.36^{a}	5.37±1.22^{a}	4.77±1.38^{cd}	5.37±1.19^{a}	4.37±1.65^{bcd}	4.83±1.37^{b}
D (0.96%)	5.57±1.28^{a}	5.33±1.01^{a}	6.03±0.72^{a}	5.63±1.13^{a}	5.50±1.23^{a}	5.77±1.04^{a}
E (1.2%)	5.60±1.22^{a}	5.33±0.88^{a}	5.50±5.37^{ab}	5.37±1.30^{a}	5.03±1.35^{ab}	5.43±1.25^{ab}

Values represent the mean ± standard deviation. Values with the same superscript letters in the same row are not significantly different (P>0.05).

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Conflict of interest

The authors declare no conflict of interest.

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