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Production, Proximate, Antioxidants and Sensory Properties of Bread Incoperated with Green Coffee (*Arabica spp*) Beans Powder

Dawi, A.W[1]&[4]., Tahir, Z.H[1]., Adebiyi, O.A[1]., Alalade O. M.[4]., Adejumo, B.M[1]., Abubakar, N.A[4]., Abubakar, U[3]., Abdulrasheed, A.A[2]., Gambo, M.A[5] and Balumi, Z.M[2]

[1]Department of Food Technology,
Federal College of Agricultural Produce Technology,
P.M.B. 3032,
Kano,
Nigeria.

[2]Department of Science Laboratory Technology,
Federal College of Agricultural Produce Technology,
P.M.B. 3032,
Kano,
Nigeria.

[3]Department of Natural Medicine Development Agency.
Federal Ministry of Science & Technology
Nigeria.

[4] Department of Food Science and Technology,
Aliko Dangote University of Science and Technology,
Wudil,
Kano,
Nigeria.

[5]Department of Hospitality Management Technology
Kano State Polytechnic,
Kano,
Nigeria.

Email: amenabrahamwakawa1@gmail.com

Abstract

Coffee and coffee based products have received tremendous attention in formulation of food products due to its significant polyphenols and antioxidants content. Coffee and coffee based products provide dietary sources such as; phenolic acid and polyphenols due to the presence of antioxidant compounds which contributes towards mood enhancing, increase alertness, weight loss, antihypertensive and anti-cancer precursors / properties. This paper aims at the production of coffee based bread that can be used as functional food. The results of the findings show that coffee based bread has a high ash content (2.64 %), fibre (1.15 %) and carbohydrates (65.06 %) content when compared with the control sample which has 1.18 % ash, 0.15 % crude fibre and 49.96% carbohydrates. While, a significant decrease was noticeable in moisture content (27.75 to 19.40 %), protein (11.95 to 6.24 %) and fat (8.98 to 5.51 %) with an increase in coffee bean. The result of antioxidants value showed a slight decrease in ferric

Author for Correspondence

reducing power (FRP) (µg/100mL), and Di-Phenyl-Picryl-Hydrazyl (DPPH) while total phenolic content (TPC) indicates a significant increase. The results of the sensory attributes of the coffee base bread showed that at high proportion of coffee inclusion, the bread was must preferred by the panelist in sample WFG^{20} (7.93) and WFG^{16} (7.00) for appearance, taste WFG^{20} (8.27), texture WFG^{20} (7.67) mouth feel (8.07) and the overall acceptability (8.13) whereas, sample WFG^{4} was least preferred by the panelists in all the parameters evaluated. This implies that inclusion of coffee does not only improves the nutritional quality but also gives high appeal to consumers. It can be concluded that fortification of bread (food) using Green Coffee Bean powder (GCB) would help improve health and wellness as well as the consumers appeal.

Keywords: Functional food, Bread, Coffee, Quality Evaluation and Antioxidants

INTRODUCTION

According to Kwak and Jukes, (2001), functional foods referred to as whole or processed foods are fortified with compounds that have significant health benefits above its normal nutritionals values / quality. Functional foods are foods which are uniformly the same as the conventional food samples with a dense nutrient consumed within daily dietary patterns with additional health benefits towards curing compounds such as phenolic acid, antioxidants and polyphenols which distinguish functional foods from conventional food (Muhammad *et al.,* 2018). High demand for functional foods grows increasingly in the developed countries in recent years. Bread is an example of functional food and a carrier for antioxidants.

Bread is a common source of carbohydrates and it is one of the many diets consumed globally depending on different preparation methods. Bread serves as a human food providing daily energy requirements and through fortification it serves as a carrier of vitamins and minerals such as; folate, zinc, iron phytic acid, thiamine, copper as well as plausibly macro nutrients and melanoidin as reported in similar study by Helou *et al.,* (2016). Bread fortified with sources of active compounds such as antioxidants could be a good source and a carrier for delivering phenolic antioxidants compounds, dietary digestible fibre and polysaccharides at high concentrations (Sivam *et al.,* 2010).

Green coffee beans are a major source of dietary, polyphenols and phenolic compounds as a result of high polyphenols, scavenging activities and phenolic acid as described by Jeszka-Skowron *et al.,* (2016). These compounds are associated with high antioxidant release in food during consumption, help in weight loss and make individual's mood bright, enhancing level of their reasoning capacity, increase alertness and its effective against hypertension and a potential anticancer properties (Jeszka-Skowron *et al.,* 2016). The high intake of green coffee beans bread has increased significantly after discovering its health properties and benefits. Coffee powder improved glucose tolerance in the body and lowered the risk of type 2 diabetes mellitus, reduces the risk of cancer cells spreading in the body as reported by Higdon and Frei, (2006; Butt and Sultan, (2011).

Some plant foods including coffee beans are rich in caffeine and also serves as a carrier in food. The health concerns on high intake of direct caffeine and its adverse effects had been alarming, especially among pregnant women, infants and the young adults (Heckman *et al.,* 2010). Butt and Sultan, (2011) reported that a moderate daily intake of caffeine is (≤ 400 mg) which was reported to have less adverse effects on health (Butt and Sultan, 2011) especially when incorporated in a food diets. The dose level for pregnant women and children is (< 300 mg/d) and (< 2.5 mg/kg) of their body weight per day which indicates that is free from any effects as analyzed in clinical trials by Nawrot *et al.,* (2003). According to Heckman *et al.,* (2010)

reported that high concentration of caffeine intake in medications (drugs) could pose a life-threatening overdose. High concentration of caffeine intake depends on individual body weight and sensitivity which indicates the following symptoms or reacts to the body by causing anxiety, headache, increased blood pressure, drowsiness and nausea as reported in different studies conducted by Nawrot, *et al.,* (2003); Butt and Sultan, (2011); Floegel *et al.,* (2012). The caffeine content of coffee variable depends on the sources, variety, maturity stage of the green coffee beans (GCB) and the method of their preparation for utilization (Floegel *et al.,* 2012).

The inclusion of green coffee beans powder as a functional food such as polyphenols, antioxidants and dietary fibre into staple food such as bread has grown rapidly due to its high demand and awareness on the health benefits (Sivam *et al*., 2010). This study therefore, aimed at production and evaluation of coffee based bread for its proximate composition containing different percentage ratio of green coffee bean compared with control from a 100% wheat flour.

METHODOLOGY

Sample collection

A semi processed green coffee bean (*Arabica spp)*, was obtained from Cocoa Research Institute, Ibadan while, refined wheat flour, yeast, sugar-syrup, margarine and salt was purchased in Singer-market, in Fagge Local government area, Kano state.

Table 1.0: Research design for the formulation of coffee based bread

S/N	Refined wheat flour (g)	Green coffee bean powder (g)	Percentage ratio in (100 %)
1.	480	20	96:4
2.	460	40	92:8
3.	440	60	88:12
4	420	80	84:16
5.	400	100	80:20

Table 2.0: Recipe for Bread Incorporated with Green Coffee Beans Powder.

S/N	Ingredients	Ratio (g)
1.	Wheat flour	500 for control
2.	GCB powder	Different ratio
3.	Iodized salts	6
4	Sugar syrup	10
5	Yeast	5.5
6.	Treated water	500 ml
7	Baking powder	2.5

Formulation of flour blends

The bread samples were formulated from the following ingredients and their proportion in grams; wheat flour 500 g, sugar iodized salts 6 g, yeast 5.5 g and treated water 500 mL. The ratio of green coffee bean (GCB) powder used in the preparation of bread samples are; 4% (WFG^{4}; 20 g/500 g) of refined wheat flour and green coffee bean blends, 8% (WFG^{8}; 40g/500 g), 12% (WFG^{12}; 60 g/500 g) 16% (WFG^{16}; 80 g/500 g), 20% (WFG^{20}; 100 g/500 g) respectively as given in Table 1.

Production of wheat – green coffee based bread

The ingredients for the preparation of coffee base breads was mixed with warm water at temperature of 37-40 ^{o}C where the yeast was added to the flour and all the ingredients were subsequently added to make a dough as described by Muhammad *et al.,* (2018). The prepared dough were allowed to stand as first fermentation stage by leaving at an elevated temperature above the room temperature for an hour then kneads and folded repeatedly for the second fermentation process to take place then the dough were left at room temperature for 25 min in a proofer proof for a quality bread with all the required and baked at 220 ^{o}C for 30 min after which it was cooled down to room temperature as described by Muhammad *et al.,* (2018).

METHOD OF ANALYSIS

Proximate Composition

Proximate composition of functional bread samples was carried out on the different blends formulated. The proximate composition which includes; ash, moisture, crude fats, and crude fibre content were analysed according to the methods of Onwuka (2018). While, the carbohydrate content were analyzed by percentage (%) difference as described by Onwuka, (2018). The percentage crude protein content were analysed using micro-kjeldahl apparatus which includes; digestion, distillation and titration method as described by AOAC (2000).

Determination of Antioxidants

Total phenolic content (TPC) of coffee-bread samples were analyzed following a method of (Michalska *et al.,* 2008). 2,2-Di-Phenyl, Picryl-Hydrazyl (DPPH) an active compound of antioxidant activity were quantified according to the methods of Culetu *et al.,* (2016) using 80% aqueous methanol extract. Ascorbic acid (Vitamin C) content was used as control in the analysis. An extracts of free scavenging radicals were analyzed. An estimation of chelating ability of ferrous ion were carried out following a standard method (Rajauria *et al.* 2013) with sight modification. The mixture reacted when shaken vigorously before the samples are analyzed and the absorbance was recorded at 562 nm with a micro-titer plate digital reader.

Sensory Evaluation of Green Coffee Based Bread

The sensory attributes were assessed on coffee based bread formulated from wheat, coffee powder. The bread samples made from 100 % refined wheat flour were used as control and sensory attributes evaluated by a 12 – member semi trained panelists using 9 Point Hedonic scale ranged from nine (9) referred to "liked extremely" down to one (1) which referred to "disliked extremely". The samples were rated for the following parameters; appearance, taste, texture, mouth feel and general acceptability, the data generated were analyzed statistically for mean and standard deviation as described by Onwuka (2018).

Statistical Analysis of Green Coffee Based Bread

The data obtained from the laboratory, had the panelists responses for the sensory evaluation was analyzed statistically using (Minitab 17), for analysis of variance (ANOVA), using one way analysis of variance and least significant difference (LSD) using Turkey's test (Onwuka, 2018).

RESULTS AND DISCUSSION

Proximate Analysis of Coffee Base Bread

Table 3.0, show the results of proximate composition of coffee based bread; the moisture content ranged from the highest value in sample WWG (27.75 %) to the lowest in sample

WFG^{20} (19.40 %) with a continuous decrease from control to the highest % inclusion of green coffee. The percentage ash content had the highest mean value in sample WFG^{20} (2.64 %) followed by WFG^{16} (2.20 %) to the lowest in sample WFG^{4} (0.93 %) respectively, meanwhile protein and crude fat decreases from sample WWF to WFG^{20}. The result shows an increase in crude fibre and % carbohydrate content.

Table 3.0: Proximate Analysis of Coffee Based Bread.

Samples	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fibre (%)	CHO (%)
WWG	27.75±0.05^{a}	1.18±0.01^{c}	11.95±0.29^{a}	8.98±0.25^{a}	0.51±0.05^{c}	49.63±0.98^{e}
WFG^{4}	26.52±0.08^{b}	0.93±0.04^{d}	11.08±0.30^{a}	8.51±0.16^{a}	0.69±0.08^{c}	51.27±1.00^{d}
WFG^{8}	23.85±0.11^{c}	1.35±0.01^{c}	9.46±0.16^{b}	8.10±0.11^{a}	0.85±0.11^{b}	58.39±1.14^{c}
WFG^{12}	21.96±0.05^{d}	1.44±0.01^{c}	8.55±0.76^{c}	7.94±0.45^{b}	0.92±0.12^{b}	59.93±1.10^{c}
WFG^{16}	19.85±0.45^{e}	2.20±0.05^{b}	8.15±0.45^{c}	6.44±0.62^{c}	0.91±0.15^{b}	62.45±1.04^{b}
WFG^{20}	19.40±0.46^{e}	2.64±0.09^{a}	6.24±0.29^{d}	5.51±0.21^{d}	1.15±0.01^{a}	65.06±0.58^{a}

*Different superscripts in same column are significantly different between the sample mean at (P<0.05).
Key: WWF (100%) Refined Wheat Flour as a control sample; WFG^{4} (96:4%); WFG^{8} (92:8%); WFG^{12} (88:12%), WFG^{16} (84:16%) and WFG^{20} (80:20%) of wheat flour to green coffee bean inclusion accordingly.

Antioxidant Properties of Coffee Based Bread

The result of antioxidants substance in the coffee based bread as shown in Table 4.0 showed that ferric reducing power (FRP) mean value ranged between 0.278 µg/1000mL to 0.3665µg / 1000mL, in which sample WFG^{20} had the highest mean score of 0.3665µg/1000mL followed by sample WFG^{8,} WFG^{12} and WFG^{16} with a mean value of 0.3458 µg/1000mL, 0.3380 µg / 1000mL and 0.3275 µg / 1000mL respectively. Meanwhile, sample WWF had the lowest mean score of (0.2780 µg / 1000mL). The result of DPPH as given on Table 4.0, shows that there was a decrease in the mean value of the DPPH with an increase in coffee powder in the bread which ranged from 96.258 to 49.21 µg / 1000mL from sample WWF to WFG^{20} respectively. The total phenolic content shows a significant difference in all the samples analyzed in an increasing order from the control sample to 20 % substitute of wheat flour to that of green coffee bean blends in which sample WWG had the lowest mean value followed by WFG^{4,} WFG^{8,} WFG^{12} WFG^{16} and WFG^{20} with a continuous increase (71.56, 78.76, 65.91, 94.00, 98.84 and 115.13), respectively.

Table 4.0: Antioxidant Properties of Coffee Based Bread

Sample code	(FRP (ug/1000ml)	DPPH	TPC
WWG	0.3665±0.00^{a}	96.28±1.05^{a}	71.56±0.15^{e}
WFG^{4}	0.3485±0.01^{a}	93.35±1.21^{a}	78.76±0.01^{e}
WFG^{8}	0.3380±0.01^{a}	89.56±1.11^{a}	65.91±0.81^{d}
WFG^{12}	0.3275±0.02^{a}	88.59±1.13^{a}	94.00±0.00^{c}
WFG^{16}	0.2960±0.00^{a}	83.05±1.09^{a}	98.84±0.20^{b}
WFG^{20}	0.2780±0.02^{a}	49.21±1.15^{b}	115.13±0.20^{a}

The result shows the mean ± S.D of triplicate measurements.
*Different superscripts in same column are significantly different between the mean samples at (P<0.05).

Key: WWF (100%) refined wheat Flour as a control sample; WFG^{4} (96:4%); WFG^{8} (92:8%); WFG^{12} (88:12%), WFG^{16} (84:16%) and WFG^{20} (80:20%) of wheat flour to green coffee bean inclusion accordingly.

Sensory Analysis of Coffee Based Bread

Table 5.0 show the results of the sensory attributes of coffee based-bread. The bread sample were subjected to panelists' tests, (9) point Hedonic scale was used. Sample coded WFG^{20} was most preferred by the panelists followed by sample WFG^{20} and sample WFG1^{6} (4.27) has the lowest rating in terms of appearance. The results of the taste in Table 5.0, also shows that the sample WFG^{20} with 20 % level of coffee was most preferred while sample WFG^{8} was the least preferred by the panelists which range from 8.27 to 4.33 respectively. The results shows that

sample WFG^{20} has the highest score for mouth feel (8.07) followed by sample WFG^{16} (7.66) down to the lowest rating by the panelists is sample WFG^{8} (6.53). The result of overall acceptability ranged from 8.13 to 6.20 with sample WFG^{20} being the most preferred and sample A found to be least preferred by the panelists respectively.

Table 5.0: Sensory Attributes of Coffee Based Bread

Samples	Appearance	Taste	Texture	Mouth feel	Overall acceptability
WWG	6.20 ± 0.08^{b}	7.46 ± 0.46^{a}	4.46 ± 0.51^{c}	7.66 ± 0.91^{a}	6.20 ± 0.66^{c}
WFG^{4}	6.06 ± 0.38^{b}	6.40 ± 0.18^{c}	5.67 ± 0.49^{b}	5.67 ± 10.49^{d}	6.27 ± 0.39^{c}
WFG^{8}	4.27 ± 0.94^{c}	4.33 ± 0.93^{d}	4.33 ± 0.67^{c}	7.46 ± 0.06^{b}	4.40 ± 0.16^{d}
WFG^{12}	6.13 ± 0.99^{b}	6.47 ± 0.10^{c}	6.53 ± 0.23^{a}	6.53 ± 0.17^{c}	6.40 ± 0.06^{c}
WFG^{16}	7.00 ± 0.85^{a}	6.86 ± 0.51^{b}	6.66 ± 0.16^{a}	7.66 ± 0.23^{a}	7.00 ± 0.89^{b}
WFG^{20}	7.93 ± 0.62^{a}	8.27 ± 0.96^{a}	7.67 ± 0.79^{a}	8.07 ± 0.38^{a}	8.13 ± 0.45^{a}

*Different superscript in same column are significantly different between samples at ($P<0.05$).
Key: WWF (100%) refined wheat Flour for control sample; WFG^{4} (96:4%); WFG^{8} (92:8%); WFG^{12} (88:12%), WFG^{16} (84:16%) and WFG^{20} (80:20%) of wheat flour to green coffee bean inclusion accordingly.

DISCUSSION

The increase of total phenolic content analyzed in coffee base-bread, could be as a result of phenolic acid, antioxidants and polyphenols presents in GCB mainly chlorogenic acid as reported by Clifford, (1999). According to Dziki *et al.,* (2015) an increase in the amount of GCB resulted in an increased TPC in the coffee-bread samples produced. Low concentration of the total phenolic compound had been reported in steamed bread prepared from refined and whole wheat flour as reported by (Li *et al.,* 2015). Similarly, TPC level in bread samples prepared from refined wheat flour showed an average mean score value lower than the coffee-bread samples. TPC in control bread were generated from the phenolic compound (ferulic acid) found naturally in wheat flour after the milling process and amino acid as well as smaller peptides formed in the process of protein breaks down known as (proteolysis of protein during fermentation) of bread as well as the high amount released from the coffee beans (Dziki *et al.,* 2015).

Refined wheat bread sample tends to contained low level of TPC when compared with coffee added bread samples which may be attributed due to high phenolic and anti-oxidants compounds in coffee beans (Butt and Sultan, 2011). The addition of coffee beans into refined wheat flour for bread improves the quality, nutritional profile as well as the level of scavenging radicals in the end product which might be due to high level of proteins and fibre content in refined wheat sample except for the proportion of each samples varied with uniform recipe used for the formulation. The steps in the preparation of the bread were the same for all the samples which showed a slight changes in the TPC level when compared with the control sample coded WWF, since the main baking ingredient consists of high percentage ratio of wheat flour.

The DPPH inhibition level in bread with 12 % GCB inclusion were approximately 3 times high than the control samples produced. The results of (IC_{50} DPPH) inhibition increased its activities significantly at ($p<0.05$) level of significance with an increase in coffee level of inclusion into bread which has a high antioxidants scavenging activity than the samples produced form whole, refined wheat flour (Butt and Sultan, 2011). Meanwhile, a significant difference was observed among the samples at ($p>0.05$) in IC_{50} DPPH inhibition of bread among the 6 products formulated (Li *et al.,* 2015).

The influence of polyphenols and antioxidant activity in food samples were previously studied by (Budryn *et al.,* 2015). The current study showed a significant correlation observed between DPPH radical scavenging activity (R^2 = 0.7753), TPC and ferric reducing power (FRP) and chelating ability (R^2 = 0.6359). The research showed that FRP power of coffee-bread were significantly rich than the control sample. An increase at ($p<0.05$) in FRP was identified in coffee-bread prepared with green coffee beans (GCB) which confirm with a similar research work by (Budryn *et al.,* 2015). There was no significant differences among the samples in FRP ability between the three concentrations of GCB bread.

The sensory evaluation properties of coffee-bread produced from different proportion of wheat – green coffee beans in the preparation of bread samples were presented on Table 5.0. The inclusion of green coffee beans (GCB) used in preparation of bread results in an increased scores for 16 and 20 % level of coffee inclusion contributes to the consumers acceptability significantly. Bread is a staple food consumed in different countries globally, were the formulation depends individual culture and preference which differs from one locality to another. Preparation of bread samples enriched coffee as a natural additives with a bioactive compounds / ingredients is a sound approach to improve the nutritional and sensory parameters. However the improved coffee bread samples expected to be palatable t c meet up with the consumer requirement (Dziki *et al.* 2015). Addition of green coffee bean (GCB) impacted a slight colour of the bread crumbs and the crust which contributes to the attributes such as; color / appearance, texture, taste significantly improves the sensorial quality. Although, the GCB inclusion disrupt the gluten matrix microstructure continuity in the samples, thereby affecting the loaf volume as well as the textural properties of the bread (Dziki *et al.* 2015). Meanwhile, the consumer's preference was high in terms of appearance and taste when compared with whole wheat bread. Although, the texture of coffee based bread was negatively affected by addition of coffee.

CONCLUSION

This study investigated the addition of coffee powder in bread formulation. The addition of green coffee would increase functional properties of coffee bread which increase the polyphenols, phenolic content and antioxidant properties compared to the control bread. Increasing amount of green coffee resulted in increased phenolic content and antioxidant activity in coffee based bread. However, the addition of green coffee resulted in reduced protein values of the bread, ash and fibre content were found to increase which indicate an increase in mineral content of the bread. Addition of green coffee in the bread samples formulation also added to the preference of the bread samples in terms of organoleptic properties. It is therefore, recommended to add green coffee powder in bread formulation due it its nutritional profile which would improve the functional and health benefits of the bread. Hence, a research gap in the area of vitamin and mineral content could be carried out.

REFERENCES

AOAC, (2000). *Official Methods of Analysis*.19th edn. Association of Official Analytical Chemists, Washington, DC.

Budryn, G., Nebesny, E., and Oracz, J., (2015). Correlation between the stability of chlorogenic acids, antioxidant activity and acrylamide content in coffee beans roasted in different conditions. *Int. J. Food Prop.* 18 (2), 290–302.

Butt, M., and Sultan, M. (2011). Coffee and its consumption: benefits and risks. *Critical Reviews in Food Science and Nutrition*, 51(4), 363-373.

Clifford, M.N., (1999). Chlorogenic acids and other cinnamates–nature, occurrence and dietary burden. *J. Sci. Food Agri.* 79, 362–372.

Culetu, A., Fernandez-Gomez, B., Ullate, M., Del Castillo, M.D., and Andlauer, W., (2016). Effect of theanine and polyphenols enriched fractions from decaffeinated tea dust on the formation of Mallard reaction products and sensory attributes of bread. *Food Chem.* 197, 14–23.

Dziki, G.D., Pecio, Ł., Ró-zyło, R., S´ wieca, M., Krzykowski, A., and Rudy, S., (2015): Ground green coffee beans as a functional food supplement–Preliminary study. *LWT-Food Sci. Technol.* 63 (1), 691–699.

Floegel, A., Pischon, T., Bergmann, M., Teucher, B., Kaaks, R., and Boeing, H. (2012). Coffee consumption and risk of chronic disease in the European Prospective Investigation into Cancer and Nutrition (EPIC) Germany study. *The American Journal of Clinical Nutrition* 95(4), 901-908.

Heckman, M.A., Weil, J., and Gonzalez, de-Mejia, E., (2010). Caffeine (1, 3, 7-trimethylxanthine) in foods: a comprehensive review on consumption, functionality, safety, and regulatory matters. *Journal of Food Science* 75(3), R77-R87.

Helou, C., Gadonna-Widehem, P., Robert, N., Branlard, G., Thebault, J., Librere, S., Jacquot,S., Mardon, J., Piquet-Pissaloux, A., Chapron, S., Chatillon, A., Niquet- Léridon, C and Tessier, F.J., (2016a.). The impact of raw materials and baking conditions on Mallard reaction products, thiamine, folate, phytic acid and minerals in white bread. *Journal of Food Functs.* 7 (6), 2498–2507.

Higdon, J., and Frei, B. (2006). Coffee and health: a review of recent human research. *Critical Reviews in Food Science and Nutrition*, 46(2), 101-123.

Jeszka-Skowron, M., Sentkowska, A., Pyrzyn´ ska, K., and Paz De Peña, M. (2016). Chlorogenic acids, caffeine content and antioxidant properties of green coffee extracts: influence of green coffee bean preparation. *Eur. J. Food Res. Technol.* 242 (8), 1403–1409.

Kwak, N.S., Jukes, and D.J., (2001). Functional foods. Part 1: the development of a regulatory concept. *Food Cont.* 12 (2), 99–107.

Li, L., Liu, H., Yu, Y., Lin, S.D and Mau, J. (2015). Quality and antioxidant property of buckwheat enhanced wheat bread. *Food Chemistry*. 37: 461- 467.

Michalska, A., M. Amigo-Benavent., H. Zielinskia., and M. D. del Castillo, (2008): "Effect of bread making on formation of maillard reaction products contributing to the overall antioxidant activity of rye bread," *Journal of Cereal Science*, 48 (1), 123-132.

Muhammad Zuhair Mohd Zain; Ahmad Salihin Baba and Amal Bakr Shori (2018): Effect of polyphenols enriched from green coffee bean on antioxidant activity and sensory evaluation of bread. *Journal of King Saud University – Science,* Vol. 30, Page: 278–282

Nawrot, P., Jordan, S., Eastwood, J., Rotstein, J., Hugenholtz, A and Feeley, M. (2003). Effects of caffeine on human health. *Food Additives and Contaminants*, 20(1), 1-30.

Onwuka, G.I (2018). Food analysis and instrumentation, theory and practice. **2rd edition**, Napthali printing press, a division of HG support Nig. Ltd. #Adeniyi Jones close, Surulere, Lagos, Nigeria. Pp: 179-348.

Rajauria, G., Jaiswal, A., Abu-ghannam, N. and Gupta, S., (2013). Antimicrobial, antioxidant and free radical scavenging capacity of brown seaweed himanthalia elongata from western coast of Ireland. *J. Food biochem.* 37 (3), 322–335.

Sivam, A. S, Sun-Waterhouse, D. Y. Q. Siew, and C. O. Perera, (2010): "Properties of bread dough with added fiber polysaccharides and phenolic antioxidants: A review," *Journal of Food Science*, vol. 75, no. 8, pp. 163-174.