PHYSICAL CHARACTERISTIC, PROXIMATE COMPOSITION, POLYPHENOL AND ANTIMUTRITIONAL FACTORS OF CHOCOLATE PRODUCED FROM NEW NIGERIAN COCOA VARIETY

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Abstract: Investigation was conducted on the physical characteristic, proximate composition, polyphenol and anti-nutritional factors of chocolate produced from different cocoa hybrids (TC1, TC2, TC3, TC4 and TC5). The cocoa were fermented with tray and then sundried. Chocolate were produced from the bean’s liquor of the different cocoa hybrid using standard methods. The physical, proximate, polyphenol and anti-nutritional properties of the chocolate were determined using standard methods. The average proximate composition of the chocolate samples were protein (6.29 to 7.29%), crude fat (31.96 to 34.28%), crude fiber (2.35 to 2.58%), total ash (2.24 to 2.65%), moisture (5.17 to 5.49%), dry matter (94.51 to 94.83%) and Nitrogen free extract (NFE) (48.76 to 57.73%). The vitamin A content of the chocolate sample also ranges from 233.16 to 258.55 µg/100g. The average total polyphenol of the chocolate sample were catechin (0.42 to 0.72mg/100g), Epicatechin (0.42 to 0.72mg/100g), caffeine (0.23 to 0.44%), Theobromine (0.33 to 0.64mg/100g) and antioxidant (66.26 to 78.14TE/100g) respectively. The result of the physical property revealed that the samples were significantly different (p< 0.05) from one another. The utilization of different varieties of cocoa causes significant differences in the physical, proximate, total polyphenols of chocolate produced.

Keywords: Chocolate, Cocoa hybrids, Proximate composition, Polyphenol, Antinutritional factors, Catechin, Epicatechin, Theobromine,

I. INTRODUCTION

Cocoa (Theobroma cacao) originated from Amazonian region of Brazil and it is a perennial tree crop grown in tropical countries which forms the economic backbone of such countries as Nigeria, Ghana, Ivory Coast, Brazil, Malaysia, Venezuela and Indonesia with over 66% produced by smallholder farmers in West Africa (Beckett, 1994: Afoakwa et al., 2011). Since the introduction of the crop into Nigeria in about 1874 (Oyedele, 2007; Oke and Omotayo, 2012), it has grown to be major export crop (Afoakwa et al., 2011). The qualities of cocoa beans depend on many factors such as the genotype, the agronomic management and climatic conditions (Brunetto et al., 2005). However, the production of this export crop in Nigeria has suffered a reduction in recent years owing to some factors such as low yield, inconsistent
production pattern, disease incidence, pest attack and use of crude farm tools (Villalobos, 1989; Oluyole and Sanusi, 2009). Hybrids of cocoa was reported by Dias et al., (2003) to show wide adaptability and an outstanding performance for yield and its components, compared to unimproved traditional local cultivars (Souza and Dais, 2004). A research carried out by Oyedokun et al., (2011) on fourteen genotypes of cocoa showed significant differences with respect to the eight quantitative morphological variables examined. In order to solve the problem associated with old established cocoa in Nigeria, effort was put in by breeders in Cocoa Research Institute of Nigeria which brought about new varieties (CRIN TC1 to CRIN TC12) in 2013. Cocoa is widely consumed in form of chocolate with increasing popularity in the world (Tafuri et al., 2014)

Information has been provided on influence of certain farming practices on old grown cocoa beans and subsequent chocolate quality such as F3 Amazon, Trinitario, Criollo and Forastero. Therefore, there is a need to also establish the same for the newly grown cocoa varieties.

II. METHODOLOGY

Source of materials

One hundred matured cocoa pods of uniform sizes and ripening was harvested per variety from a new cocoa hybrid trial plots established at Cocoa Research Institute of Nigeria (CRIN), Headquarters, Ibadan, Nigeria. A total of 500 pods resulting from five varieties (TC1, TC2, TC3 TC6, and TC7) constituted an experimental unit. Other materials such as sugar, lecithin, cocoa butter and foil paper were purchased from Oyingbo open market, Lagos State, Nigeria.

Methods

Fermentation and drying of cocoa beans

Fresh beans removed from selected pods of each variety were bulk fermented in tray for 5-6 days in three replicates using the method of Aroyeun (2007). Fermented beans from each variety were subjected to sun drying to about 7% moisture.

Production of chocolate from fermented cocoa beans

Chocolate was produce from the fermented cocoa varieties using the method described by ICCO, 2005 and Paula, 2013. The chocolate samples (high cocoa content) were obtained using the following proportions cocoa liquor (63.0%), cocoa butter (7.0%), sugar (29.60%) and lecithin (0.4%) and were prepared in Cocoa institute of Nigeria, CRIN Ibadan, Nigeria. The seeds were triturated to remove the peel and germ in order to obtain cocoa nibs. The nibs were ground in a knife-grinder, with sugar added in this phase. The cocoa paste was then refined in a grinderroller, yielding a cocoa paste with an adequate granulation (21 µm) for making chocolate. The refined paste was subjected to conching in a horizontal shell at 60 °C.

Determination of physical properties of the Chocolate

Melting point and colour were determined using a differential scanning calorimeter, heat flow type method as described by Bolliger et al., (1998).

Proximate analysis of the Chocolate

Moisture, crude protein content, crude fibre, crude fat and total ash contents were determined by methods described by Tell and Hagarty, 1984; AOAC, 2000 while nitrogen free extract was determined by difference i.e \[ 100 - (\% M + \% CP + \% ash + \% CP + \% CF) \]

Determination of Polyphenol content and anti-nutritional factors of the Chocolate

Phenol content and flavonoid of the Chocolate were determined according to Karim et al., 2000, catechin and epicatechin were determined according to ACOA, 1979. Anti-nutritional factor like Tannins was determined according to method described by SWAIN (1979), Theobromine was determined by spectrophotometric method as described AOAC, 1974 while caffeine was evaluated with reverse phase high performance liquid chromatography as described by AOAC, 2000; ACOA, (1979) and AOAC, (1974).
III. RESULT

Result of physical properties of the chocolate

Result of physical properties of chocolate from different varieties of new Nigeria cocoa is presented in Table 2. The melting point of the chocolate ranged from 51.58 to 53.76°C with TC5 having the lowest mean score while TC1 has the highest. The residual meter value of the chocolate ranged from 2.78 to 4.83 with TC3 having the lowest mean score while TC1 has the highest. The color of the chocolate samples ranged from 6.27 to 8.37 Hz. TC3 has the lowest mean score while TC6 had the highest. There was significant (P<0.05) difference among the samples of chocolate in all the physical parameters evaluated.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Melting point (°C)</th>
<th>Res Meter Value</th>
<th>Color (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC1</td>
<td>52.19±0.02bc</td>
<td>4.83±0.02ab</td>
<td>7.97±0.03bc</td>
</tr>
<tr>
<td>TC2</td>
<td>52.03±0.04bc</td>
<td>2.78±0.05d</td>
<td>6.27±0.02c</td>
</tr>
<tr>
<td>TC3</td>
<td>52.64±0.01b</td>
<td>4.29±0.01b</td>
<td>7.64±1002c</td>
</tr>
<tr>
<td>TC5</td>
<td>51.58±0.02c</td>
<td>3.79±0.03d</td>
<td>8.37±0114</td>
</tr>
<tr>
<td>TC6</td>
<td>53.76±0.03a</td>
<td>3.61±0.03c</td>
<td>7.35±0.14d</td>
</tr>
</tbody>
</table>

Values are means ± standard deviation of duplicate determinations. Difference letter scripts in the same column indicate statistical difference (P<0.05)

<table>
<thead>
<tr>
<th>Sample</th>
<th>Protein (%)</th>
<th>Crude (%)</th>
<th>Fat (%)</th>
<th>Crude fibre (%)</th>
<th>Ash (%)</th>
<th>Moisture content (%)</th>
<th>Dry Matter (%)</th>
<th>Carbohydrate (%)</th>
<th>Vitamin (µ/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC1</td>
<td>6.29±0.02</td>
<td>31.96±0.03</td>
<td>23.57±0.02</td>
<td>2.24±0.02</td>
<td>5.43±0.02</td>
<td>94.57±0.02</td>
<td>51.73±0.02</td>
<td>248.60±0.00</td>
<td></td>
</tr>
<tr>
<td>TC2</td>
<td>6.37±0.07</td>
<td>32.15±0.11</td>
<td>2.38±0.02</td>
<td>2.31±0.05</td>
<td>5.49±0.02</td>
<td>94.51±0.04</td>
<td>51.30±0.02</td>
<td>235.16±0.01</td>
<td></td>
</tr>
<tr>
<td>TC3</td>
<td>6.98±0.02</td>
<td>33.75±0.07</td>
<td>2.54±0.03</td>
<td>2.57±0.03</td>
<td>5.22±0.02</td>
<td>94.78±0.02</td>
<td>48.94±0.02</td>
<td>242.88±0.00</td>
<td></td>
</tr>
<tr>
<td>TC4</td>
<td>7.29±0.03</td>
<td>34.28±0.01</td>
<td>2.65±0.01</td>
<td>2.63±0.02</td>
<td>5.17±0.12</td>
<td>94.83±0.05</td>
<td>48.19±0.02</td>
<td>253.55±0.01</td>
<td></td>
</tr>
<tr>
<td>TC5</td>
<td>7.13±0.02</td>
<td>33.52±0.02</td>
<td>2.58±0.04</td>
<td>2.65±0.04</td>
<td>5.36±0.02</td>
<td>94.64±0.02</td>
<td>48.76±0.02</td>
<td>244.2±0.02</td>
<td></td>
</tr>
</tbody>
</table>

Values are means ± standard deviation of duplicate determinations. Difference letter scripts in the same column indicate statistical difference (P<0.05)

Keys, TC1 TC2 TC5 TC6 TC7 (Chocolate produced from Cocoa hybrids TC1, TC2, TC3, TC6, TC7)
Result of the total polyphenol composition of the chocolate

The result of total polyphenol of the chocolate from different varieties of Nigeria cocoa bean is shown in Table 4. Catechin content ranged from 0.49 to 0.67% with TC1 having the lowest mean score and TC3 having the highest mean score. Epicatechin content ranged from 0.24 to 0.51% TC1 had the lowest mean score while TC6 was reported to have the highest Caffeine content of the chocolate ranged from 0.23 to 0.44% with TC2 having the lowest mean score while TC6 has the highest Theobromine and antioxidant content of the chocolate ranged from 0.33 to 0.64% and 66.26 to 78.14% respectively. TC1 was observed to have the lowest mean score in terms of theobromine content while TC6 has the highest TC3 has the lowest mean m terms of antioxidant content while TC6 has the highest. However, of all the chocolate samples evaluated, TC6 was reported to have the highest mean score in terms of total polyphenol contents evaluated. There was significant (P<0.05) difference among the chocolate samples based on the total polyphenol parameters evaluated.

Table III: Result of total polyphenols and antioxidative composition of chocolate from new varieties of cocoa

<table>
<thead>
<tr>
<th>Sample</th>
<th>Catechin (mg/100g)</th>
<th>Epicatechin (mg/100g)</th>
<th>Caffeine (%)</th>
<th>Theobromine* (mg/100g)</th>
<th>Antioxidant (TE/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC1</td>
<td>0.49±0.05</td>
<td>0.24±0.04</td>
<td>0.27±0.12</td>
<td>0.33±0.03</td>
<td>67.79±0.06</td>
</tr>
<tr>
<td>TC2</td>
<td>0.53±0.04</td>
<td>030±O 03</td>
<td>0.23±0.09</td>
<td>0.49±0.05</td>
<td>76.44±0.06</td>
</tr>
<tr>
<td>TC5</td>
<td>0.67±0.12</td>
<td>043±1 06</td>
<td>0.36±0.07</td>
<td>0.45±0.02</td>
<td>66.26±0.06</td>
</tr>
<tr>
<td>TC6</td>
<td>0.62±0.17</td>
<td>0.51±0.09</td>
<td>0.44±0.08</td>
<td>0.64±0.03</td>
<td>78.14±0.08</td>
</tr>
<tr>
<td>TC7</td>
<td>0.65±0.06</td>
<td>0.39±0.06</td>
<td>0.32±0.05</td>
<td>0.60±0.06</td>
<td>75.99±0.06</td>
</tr>
</tbody>
</table>

Values are means ± standard deviation of duplicate determinations. Difference letter scripts in the same column indicates statistical difference (P<0.05)

Keys, TC1, TC2, TC3, TC4, TC6, TC7 (Chocolate produced from Cocoa hybrids TC1, TC2, TC3, TC4, TC6, TC7

IV. DISCUSSION

The result of the physical properties of chocolate produced from different cocoa varieties is presented in Table 1. The melting point of any substance is the temperature at which the substance changes from solid to liquid at atmospheric pressure (Ramsay, 1949). Schenk and Peschar (2004) reported that the normal melting point of chocolate is -33°C, and value above this may exhibit a “memory effect” recrystallization. The melting obtained for the chocolate sample in this study was similar to the normal melting point of chocolate (30 to 35°C) reported by Ouellette-Rodriguez-Campos et al., (2012) where it was stated that fermentation of cocoa beans used in the production of the chocolate resulted in darkening of the chocolates. Proximate composition is the true representation of the nutritive value of any food. Any food that contains these nutrients such as protein, carbohydrate, fat is defined as food with high nutritive value (Okechukwu et al., 2015). The proximate composition of the chocolate produced from different new cocoa varieties is presented in Table 2. The result revealed that TC1 has the lowest mean score while TC6 has the highest mean score in terms of crude protein. This is in line with the values (667%) reported by Suzuki et al., (2010) for diet dark chocolate which indicated that the crude protein content of chocolate from new cocoa beans compared favorably with that of old variety. The reduction in protein content when compared to the protein values obtained by Afoakwa et al. (2008) for some fermented cocoa beans may be due to the conching process which could have denature some protein in the chocolate (Ndife et al., 2013). Crude fat content is an important quality index for cocoa processors during purchasing of cocoa and cocoa products (Wood and Lass, 1985). Afoakwa et al., (2008) The fat content observed in this study ranged between 31.96% and 34.28%. The result of fat content obtained in this study was similar to that reported by Ndife et al., (2013) (31.25 to 35.10%) for chocolate from old varieties of cocoa beans. There was no significant difference among the
samples (P>0.05) The significant increase in the fat content of chocolate sample over that of the fermented cocoa bean reported could be as a result of the contribution of ingredients such as cocoa butter. Fats, especially the unsaturated fat are prone to oxidation and shorten shelf life of food products (Afoakwa et al., 2007) The high fat content of some samples indicates that the chocolate samples would facilitate transportation of fat soluble vitamins and also serve as source of energy (Pamela et al., 2005). Dietary fats make food tasty and they often improve the texture of food as well as flavour and smell - they make food more appealing (Pamela et al., 2005) Fat also provides very good sources of energy and aids m transport of fat soluble vitamins, insulates and protects internal tissues and contributes to important cell processes (Pamela et al., 2005) Fats was reported to helps to reduce the risk of coronary heart disease because the flavonoids in cocoa are capable to cause the modulation, prevent the oxidation and increase in cholesterol which could cause higher risk of heart diseases as reported by Osakebe et al., (2000) Fibre is considered an efficient protective agent for a wide variety of illness including cardiovascular diseases, colon cancer and constipation (Marlett et al., 2002) Crude fibre has been proved to aids peristalsis movement of food through the digestive tract (Adeleke and Odedeji, 2010). Crude fibre contributes to the bulk density which could help in the bowel movement, lower blood cholesterol and helps prevent cancer of the colon (Hung et al., 2004) The result of the crude fibre content shows the value ranged between 2.35 and 2.58% and there were no significant difference (p>0.05) among the samples These values compared favorably with the values of 2.23 to 3.16% reported by Ndife et al., (2013) for chocolate TC1 has the lowest mean score while TC7 has the highest Redgwell et al., (2003) reported that dietary fibre content of cocoa products after roasting and conching will reduce, possibly due to the interaction between polysaccharides, proteins, polyphenolics, and maillard products at high temperatures This might be the reason for the significant differences observed in the result of this present study Ash is an indicator of mineral contents of foods and has been shown by Legghet al (2011) to be high in cocoa products The ash content observed m this study ranged between 2.24 and 2.65% with TC1 having the lowest mean score while TC7 has the highest The result obtained indicated that there was higher ash content in the samples when compared with the values reported by Ndife et al. (2013) for chocolates The moisture content value obtained for the chocolate samples m this study indicated that the values fall within the standard range (5 to 7%) to reduce the eventual growth of bacteria and moulds and improve the shelf-stability of the products (Fowler, 2009, Guehi et al, 2010) High moisture content has been associated with short shelf life of products as they encourage microbial proliferation that leads to spoilage (Ezeama, 2007), avoiding microbial growth is then paramount The reduction m the moisture content of the chocolate may be as a result of further processing such as conching Dry matter content of the chocolate ranged between 94.51 and 94.83% There were no significant difference (p>0.05) among the samples studied with sample TC2 having the lowest mean score while TC1 has the highest score The lowest value obtained for TC7 indicated that it will be of lower energy level compared to other samples as reported by Jinap (1994). Nitrogen free extract is the component not analyzed and calculated m proximate analysis and does not pertain to nitrogen but focuses on sugar and starch content of the product (Free Webinary, 2018) The Nitrogen free extract (Carbohydrate) content ranged between 48.19 and 51.73% with TC5 having the lowest mean score while TC1 has the highest Vitamin A functions at two levels in the body The first is in the visual cycle in the retina of the eye, the second is in all body tissues systemically to maintain growth and the soundness of cells (WHO/FAO, 2001) The specific symptoms of vitamin A deficiency includes xerophthalmia and the risk of irreversible blindness while the non-specific symptoms include increased morbidity and mortality, poor reproductive health, increased risk of anaemia and contributions to slowed growth and development (WHO/FAO, 2001). The vitamin A content of the chocolate samples ranged between 253.16 and 253.55µg/100g. Chocolate sample from TC2 has the lowest mean score, while TC5 has the highest which indicate that chocolate from the new varieties (most especially TC5) will be of higher value. The result of the total polyphenol composition of the chocolate produced from new Nigeria cocoa varieties is as presented in Table 4. Polyphenols are organic compounds found abundantly in plants, have become an emerging field of interest in nutrition m recent decades (Cory et al., 2018). A growing body of research indicates that polyphenol consumption may play a vital role in health through the regulation of metabolism, weight, chromdisease, and cell proliferation (Cory et al., 2018) Recently, cocoa bean and its products total polyphenol have attracted a lot of attention because of their potential benefits on human being The health promoting effects of polyphenols are believed to be the result of the relatively high antioxidant activity of these compounds, which protect people from chronic diseases by reducing oxidative damage (Redovnikovic et al., 2009). The total polyphenol content of cocoa and its products also reduced the risk of cardiovascular diseases (Stephen, 2015) as well as improvement in the insulin level and insulin resistance. The result obtained from this study shows that catechin content ranged between 0.49 and 0.72%. The catechin values from this research were higher than that documented by literature for cocoa beans (0.17%). It was also documented by Woligast and Anldan (2010) that...
high temperatures and prolonged processing times may decrease the amount of catechin. Catechin have reported to be present in many dietary products, plants, fruits such as chocolate, cocoa (Anand et al., 2014) It affects the molecular mechanisms involved in angiogenesis, extracellular matrix degradation, the regulation of cell death, and multidrug resistance in cancers and related disorders (Anand et al., 2014) Epicatechin is a major component of the polyphenols in cocoa and its products and its major monomer of procyanidins (Othman et al., 2010) Epicatechins have proven diverse benefits to human health, reducing the risks of diabetes mellitus and cardiovascular diseases. Their pharmacological effects are anti-hyperlipidaemic, anti-inflammatory, antioxidative, anticarcinogenic, and cytoprotective (Nakayam et al., 1993).

The Epicatechin content of the chocolate samples ranged between 0.24 and 0.51%. There was decrease in the epicatechin content of the chocolate samples when compared to that documented for cocoa beans by Kim and Keeney (2010). Caffeine is known to be naturally present in cocoa and its products and is better xanthanoid, a stimulant and diuretic. The level of caffeine in chocolate is dependent on the degree of cocoa bean type and its fermentation degree (Nazaruddin et al., 2006). The caffeine content of the chocolate ranged between 0.23% and 0.44% with TC6 having the lowest mean while TC8 has the highest value. There were significant (P<0.05) differences among the evaluated samples and the variation in the caffeine content of the samples may be attributed to the different hybrid of cocoa beans used and the degree of their fermentation (Nazaruddin et al., 2006). Theobromine is the characteristic chemical compound found in cocoa and its products which is responsible for the bitter taste and may also possess mild stimulation properties. Furthermore, theobromine is known to stimulate heart, muscles relaxes bronchial smooth muscles in the lungs and plays an important role in the transmission of intercellular signals (Shively et al., 1984). The theobromine content in this study ranged between 0.33 and 0.64% and there was significant difference (p<0.05) among the evaluated samples. TC1 has the highest mean value of theobromine while TC6 has the highest. African cocoa beans have been reported to contain less caffeine and more theobromine than cocoa from South America (Matissek, 1997) and this result shows decreased in theobromine content of the chocolate samples. Appreciable percentage of anti-oxidant (67.99 to 78.14%) was also reported in this study which could slow down the damage to cells caused by free radicals.

V. CONCLUSION

This study had shown significant effect of different variety of new cocoa on the quality parameters evaluated. TC7 hybrid was the best in most of the parameters assessed while TC6 was the best in term of proximate composition and total polyphenols with highest mean score compared to other samples.

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REFERENCES


