



ANTIOXIDANT ACTIVITY AND BIOCHEMICAL PROFILE OF COCOA CLONES

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Cocoa is rich in polyphenols, procyanidins, fat and theobromine. Studies have revealed that cocoa beans have health benefits due to their polyphenol contents, which exhibits high antioxidant activity both *in vivo* (Kondo *et al.*, 1996) as well as *in vitro* (Baba *et al.*, 2000) conditions and offering protection against chronic diseases. Dark chocolates with more percentage of cocoa solids are considered as functional food and this fact is realized by the consumers of current century. Cocoa, cocoa extracts, purified cocoa flavanols and procyanidins exert strong antioxidant effects. Qualitative improvement with biochemical characterization is important in germplasm evaluation trials for effective breeding programs. Cocoa genotypes with high polyphenols, fat contents and superior antioxidant activities will have great attention in industrial use for making chocolates, cocoa powder, cocoa drink and other value added products. Total phenols and antioxidant activities of even unfermented beans are being utilized for cosmetic use in Malaysia (Norliza *et al.*, 2013). Antioxidant activity and biochemical components of cocoa clones is presented.

1) Biochemical characteristics

Twenty one exotic cocoa clones collections from Ecuador, Malaysia, Nigeria, Peru and Trinidad which are conserved at field gene banks

of Central Plantation Crops Research Institute (ICAR- CPCRI), Regional Station, Vittal, Karnataka. Biochemical characteristics of different cocoa clones with respect to polyphenols, procyanidins, fat content and antioxidant activities are presented in Table 1. Flavonoids and phenolic acids are known to possess antioxidant potential due to the presence of hydroxyl groups in their structures and thus contribute to defense system against the oxidative damage. The clone EET-272 showed highest polyphenol content of 136 mg/g whereas, the least of 82.41 mg/g is found in IV-20. Condensed tannins or procyanidins recorded in ICS-6 is the highest with 64.25 mg/g and the least content of 48.55 mg/g is found in NC-67. Fat content also varied from the highest of 54.33% in III-35 to the lowest of 24.67% in NA-242, among the clones.

The antioxidant activity of cocoa clones showed significant difference among the clones, widely ranging between a high of 98.8% in EET-272 and the lowest of 77.2% in NA-33. Higher percentages indicating higher antioxidant properties which are seen in clones ICS-1, I-21, II-67 except, SCA-12, ICS-95, III-105 and NC-67. The reason might be that these ethanolic extracts of clones attributed genotypic variation in reaction kinetics with ethanolic DPPH free radicals.

Table 1. Polyphenols, procyanidins, fat and antioxidant activities of different cocoa clones

Cocoa clones	Polyphenolmg/g	Procyanidinmg/g	Fat (%)	Antioxidant activity (%)
EET-272	136.2	52.46	47.67	98.8
SIAL -93	98.24	51.21	35.67	83.6
NA-33	81.43	48.25	45.67	77.2
NA-242	93.32	55.24	24.67	93.8
ICS-95	113.3	59.21	35.33	82.1
ICS-1	142.3	62.32	39.33	97.5
ICS-6	100.2	64.25	28.00	81.2
V-1	117.1	52.75	52.33	87.3
III-35	110.2	55.65	54.33	83.3
I-14	93.21	49.56	40.33	86.6
IV-20	82.41	48.85	53.67	92.9
I-56	105.2	59.22	40.00	84.6
I-21	113.3	63.46	53.67	93.2
II-67	134.9	60.21	48.67	98.1
V-7	95.22	51.10	49.00	92.6
SCA-12	100.2	51.24	39.67	89.5
III-105	102.3	42.56	30.33	66.6
II-52	98.55	52.46	32.00	82.5
I-56	103.1	51.21	49.00	92.2
NC-46	97.54	52.21	54.33	87.3
NC-67	115.5	48.55	54.34	82.2
CD	0.73	0.78	1.20	—

The biochemical contents exhibited significant positive correlation between polyphenols and antioxidant activity ($p < 0.05$, $r = 0.439$) and between polyphenols and procyanidins ($p < 0.05$, $r = 0.473$). The procyanidins also tend to show positive significant correlation with antioxidant activity ($r = 0.418$). Beans of cocoa

clones had significant variation in polyphenols, procyanidins and antioxidant activities. High contents of polyphenols and procyanidins are related with high antioxidant activities. This information may be targeted for close screening of cocoa clones further for food, health and nutritional purposes.



2) Correlation between polyphenols and antioxidant activity

The associations between biochemical contents estimated for correlation are presented in Table 2. The correlation coefficient is higher between the antioxidant capacity and procyanidins ($r=0.93$) compared to the antioxidant capacity and total phenolic content

($r=0.89$). Significant correlations between the total polyphenol content and antioxidant activity of whole wheat or milling fractions of wheat have also been reported (Zhou *et al.*, 2004). Our results are in agreement with other studies (Scibisz and Mitek, 2007) demonstrated with antioxidant capacity in high bush blueberries (*Vaccinium corymbosum* L.) which is strongly correlated with the content of total anthocyanins and total phenolics.

Table 2. Correlation of biochemical contents in different cocoa clones

Biochemical content	Polyphenols	Procyanidins	Fat	Antioxidant
Polyphenol	1.000	0.473*	0.166	0.439*
Procyanidin		1.000	-0.101	0.418
Fat			1.000	0.330
Antioxidant				1.000

*Correlation is significant at the 0.05 level (2-tailed)

The significant difference among cocoa clones with respect to total phenolics, procyanidins, fat and antioxidant activity is probably largely due to the genotypic effect, though they are grown under the same environmental conditions, as has been reported in other plant species.

- From this study it is clear that cocoa clones showed a wide range of difference in polyphenols, procyanidins, fat and antioxidant activities.
- Polyphenols and procyanidins showed significant positive correlation with antioxidant activity and favours preparation of polyphenol rich chocolates.
- High content of polyphenols and procyanidins contribute for phytochemical improvement and will play an important role in the selection of superior cocoa clones for better nutritional and health benefits.

References

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