VARIABILITY IN THE CHLOROPHYLL AND CAROTENE COMPOSITION OF TEN MAIZE (Zea mays) VARIETIES

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ABSTRACT

Grains of ten maize varieties grown in Eastern part of Nigeria were collected from National Seed Company of Nigeria Umuahia and investigated for their pigment contents. The result of the analysis of variance showed significant differences between the varieties. SUWAN-1-SR-Y was found to have highest significant amount of chlorophyll a, b and total chlorophyll (a + b) as well as carotene. The result of the correlation analysis also showed that there was statistically significant correlations ($P<0.01$) between chlorophyll a, b, total chlorophyll (a + b) and carotene composition of the maize varieties.

Keywords: Maize, pigments, varieties, chlorophyll, Correlation.

INTRODUCTION

Maize (*Zea mays* L., $2n = 2x = 20$) belonging to the family Poaceae is one of the most important crops in the word and preferred staple food for more than 1 billion people in sub Saharan Africa and Latin America (Gupta *et al*., 2009). Apart from this, maize is an important industrial raw material and provides large opportunity for value addition. Beside this maize have many types like normal yellow and white grain, sweet corn, baby corn, popcorn, waxy corn, high amylase corn, high oil corn, quality protein maize, etc. Maize is the only food cereal crop that can be grown in diverse seasons, ecologies and uses. In Nigeria, maize is known and called by different vernacular names depending on locality like agbado, igbado or yangan (Yoruba); masara or dawar masara (Hausa); ogbado or oka (Ibo); apaapa (Ibira); oka (Bini and Isha); ibokpot or ibokpot union (Efik) and igumapa (Yala) (Abdulrahaman and Kolawole, 2006).

The quantification of chlorophyll provides important information about the effects of environments on plant growth (Schlemmer *et al*., 2005). Chlorophyll content has also been suggested as the most directly relevant to the prediction of productivity (Dawson *et al*., 2003). When conducting plant research, the measurement of photosynthetic pigments can provide basic information on the physiological status of a plant. Chlorophyll analysis has been conducted in numerous studies due to the importance of this pigment in the physiology of plants. Carotenes contribute to light harvesting and also play a photo protecting role preventing damage to the photosynthetic systems (Gitelson, 2003; Merzlyak *et al*., 2003). Chlorophyll content can change in response to biotic and abiotic stresses such as pathogen infection (Mur *et al.*, 2010) and light stress (Kitajima and Hogan, 2003; Brouwer *et al.*, 2012). Chlorophyll content is an indicator for crop growth and development, therefore accurately determining and assessing of chlorophyll concentration is essential (Bannari *et al*., 2007). The main objectives of this study are to assess the corn chlorophyll composition and establish a possible correlation between the photosynthetic pigments extracted.

MATERIALS AND METHODS

Plant Material

Seeds of 10 maize (*Zea mays* L.) varieties namely Oba-98, SAMMAZ-28, SUWAN-1-SR-Y, BR9928-DMR-SR-Y, ART/98/SW-1-1, MDV-3, BR9943-DMR-SR-W, TZPB-SR-W, Oba super-2, SDM-2 were kindly provided by National Seed Company of Nigeria. These seeds were investigated for variability their chlorophyll composition. The seeds were also planted in pots under natural illumination and were used for pigment analysis when the plant had developed 4-5 leaves.

Chlorophyll Determination

This was determined using spectrophotometric method described by Sartory and Grobbelaar (1994). The plant samples were ground into paste and separated in 100 % acetone (50 ml for each gram), then homogenised with the homogeniser at 1000 rpm for one minute. The homogenate was filtered through two layer cheese cloths, and was centrifuged using the jenway centrifuge at 2500 rpm for ten minutes. The supernatant was separated and the absorbance was read at 400-700 nm on Schimadzu uv-260 spectrophotometer. It was recorded that chlorophyll (a) showed the maximum absorbance at 662 nm chlorophyll (b) at 645 rn and the amount of these pigment was calculated according to the formulas of Lichtentaler and wellburn 1985.

Formula

Acetone

$$C_a = 11.75\ A_{662} - 2.350\ A_{646}$$

$$C_b = 18.61\ A_{645} - 3.960\ A_{662}$$

Carotene Determination

Carotene was determined by method described by Mieko and Delia (2005). Five (5 g) of the test sample was homogenized using acetone solution with the aid of pestle and mortar. The solution was filtered after crushing. The filtrate was then extracted with petroleum spirit using separating funnel. Two layers of both aqueous and solvent layer were obtained. The upper layer which contains carotene was washed well with distilled water. It was later poured out into 50 ml volumetric flask through the tap of the separating funnel and made up to mark. The absorbance of the solution was read using spectrophotometer at wavelength A_{450}nm.

Calculation:

$A \times 50x10^4 / A^{1\%} \times W$

Where A is absorbance

$A^{1\%}_{1cm\ is}$ coefficient of absorption

W is weight of samples

RESULTS AND DISCUSSION

Leaf Pigment Composition

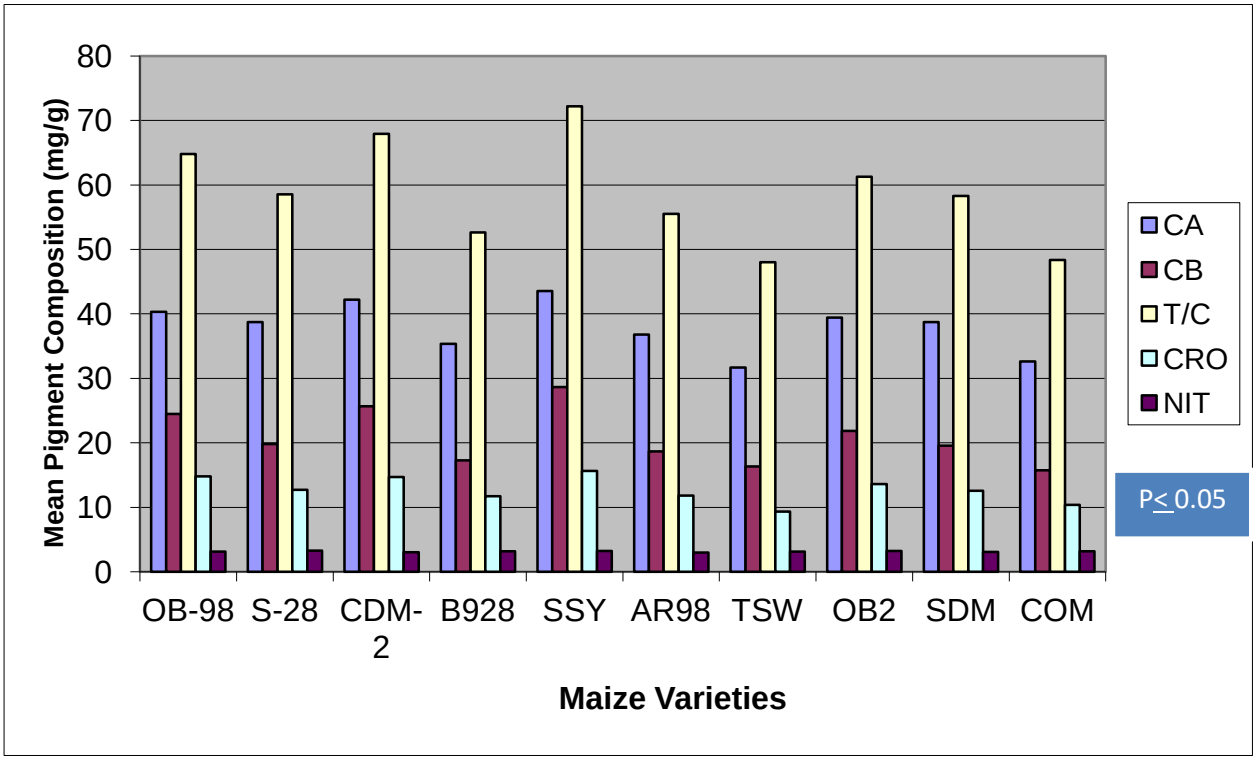

Fig 4.6: Mean average pigment and nitrogen composition of maize grains
OB =Oba 98, S-28= SAMMAZ -28, COM2 = MDV-3, B99 = BR99 43-DMR-SRW, SSY =SUWAN-1-SR-Y, AR= ART/98/SW1-1, TSW= TZPB-SR-W, OB2= Oba Super -2, BK=BR 9928DMR-SRY, SDM= SDM-2

The most abundant pigment in the leaf is Chlorophyll-a. Highest chlorophyll a, b, total chlorophyll was observed with the leaves of SUWAN-1-SR-Y variety followed by the leaves of maize variety BR 9943 DMR-SR-W.

Leaf pigment content provides valuable information about the physiological status of plants. The content of foliar pigment varies depending on species. Variation in leaf pigments (chlorophyll and carotene) and its relation can be due to internal factors and environmental conditions. Shaikh and Dongare (2008) reported that chlorophyll and carotenoids contents varied with microclimatic conditions in *Adianutm* species. The chlorophyll concentration differed among the variety of the maize leaves studied. Highest chlorophyll a, b, total chlorophyll was observed with the leaves of SUWAN-1-SR-Y variety followed by the leaves of maize variety BR 9943 DMR-SR-W. However, there were significant differences in carotene content of the leaves. SUWAN-1-SR-Y (15.63 mg/g) had the highest significant ($P<0.05$) carotene content followed by OBA 98 (14.82 mg/100g**)** and BR9943-DMR-SR-W (14.73 mg/100g) while the lowest was observed TZPB-SR-W (9.37 mg/100g). Photosynthetic pigments that are present, their abundance and photosynthetic efficiency of the plant vary with the species and stage of development of this one. Chlorophyll and nitrogen are important components which are present in plant leaves. Deficiency of the two may cause lower or unhealthy productions (Prajakta and Anup, 2014). Chlorophyll content has been suggested as the most directly relevant to the prediction of productivity (Dawson *et al*., 2003). Carotenoids are integral constituents of the thylakoid membrane and are usually

well associated with many of the proteins that constitute the photosynthetic apparatus (Sikuku *et al*., 2010).

They represent an important role in the light-harvesting complex, as well as in the photoprotection of the photosystems. Some reports show that these compounds are very important in the preservation of the photosynthetic apparatus against photo- damage by their interconversion with xanthophyll molecules (ORT, 2001). The distribution of Chlorophyll within maize leaves is, in general, quite homogeneous at a specific growth stage. However, either biotic or abiotic factors can induce stress in a plant affecting specific processes on individual leaves resulting in both a loss of chlorophyll and a change in its distribution pattern (Barton, 2000). The amount of solar radiation absorbed by a leaf is a function of the photosynthetic pigment content. Thus chlorophyll content can directly determine photosynthetic potential or primary production. In addition chlorophyll gives an indirect estimation of nutrient status because much of the leaf nitrogen is incorporated in chlorophyll (Moran *et al*., 2000).

Table 4.1: Correlation analysis between chlorophyll and carotene contents of different maize leaves

	C/A	C/B	T/C	CRO
C/A	1			
C/B	0.939**	1		
T/C	0.983**	0.986**	1	
CRO	0.973**	0.951**	0.976**	1

** Correlation is significant at the 0.01 level.
C/A =chlorophyll a, C/B= chlorophyll b, T/C= total chlorophyll and CRO = carotene

The relationship between chlorophyll a, b, total chlorophyll and carotenoid concentrations were investigated. The result of the correlation analysis showed that there were statistically significantly correlations ($P<0.01$) between chlorophyll a, b, total chlorophyll (a + b) and carotene contents of the plant studied. This implies that any increase in one of the components would correspond to an increase in the other components. Several studies showed that there is a correlation between the dominant pigment concentration and one or more chromatic parameters such as carotenoids in apricots (Ruiz *et al*., 2005), orange juice (Melendez-Martinez *et al*., 2003) and chlorophyll in pepper leaves (Medeira *et al*., 2003).

CONCLUSION

The result of this study indicated that the chlorophyll concentration differed among the variety of the maize leaves studied and that the most abundant pigment in the leaf is Chlorophyll-a. Highest chlorophyll a, b and total chlorophyll was observed with the leaves of SUWAN-1-SR-Y variety followed by the leaves of maize variety BR 9943 DMR-SR-W. However, there were significant differences in carotene content of the leaves. SUWAN-1-SR-Y (15.63 mg/g) had the highest significant ($P<0.05$) carotene content followed by Oba-

98 (14.82 mg/100g**)** and BR9943-DMR-SR-W (14.73 mg/100g) while the lowest was observed TZPB-SR-W (9.37 mg/100g).

It was also observed that there was correlations (P<0.01) between chlorophyll a, b, total chlorophyll (a + b) and carotene contents of the plant studied.

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