Physicochemical characteristics and nutritional potential of Parkia biglobosa ecotypes fruit pulps from Burkina Faso

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Abstract

African locust bean (ALB) is a fruit tree indigenous to the savannah drylands of sub-Saharan Africa. The pulp and seeds of ALB are used as food and for income generation. The fruit pulp, despite its large consumption, has not received so far significant attention regarding its biochemical composition.
The study aimed to determine the physicochemical characteristics and potential nutritional value of ALB pulp collected from three phytogeographical regions of Burkina Faso and to determine whether the nutritive attributes and colour characteristics varied with the origin of the samples. Results indicated different level of vitamin C (1.11 ± 0.01 to 27.85 ± 0.25 mg/100g DW), and α-carotene (0.05 ± 0.01 to 1.38 ± 0.09 mg/100 g DW).
Three different sugars, namely fructose (2.59 ± 0.02 to 6.35 ± 0.09 g/100 g DW), glucose (2.58 ± 0.19 to 6.31 ± 0.1 g/100 g DW) and sucrose (9.38 ± 0.11 to 15.71 ± 0.43 g/100 g DW) were detected in the pulp.
With regard to colour characteristics, the average yellow index value was highest (87.17 ± 2.23) in the South-Soudanian ecoregion and lowest (62.51 ± 1.47) in the North-Soudanian ecoregion. Parkia pulp colour characteristics and nutrient content (except for the °Brix value) varied significantly (*P*< .0001) among the selected provenances. The results showed significant variation (*P*< 0.05) in pulp pH, acidity, colour characteristics, glucose, fructose, sucrose, α-carotene and vit C content among the trees sampled, while no significant difference was found for °Brix.

Keywords: Parkia biglobosa**,** pulp, colour, nutritional characteristics

Caractéristiques physicochimiques et potentiel nutritionnel des pulpes de fruits des écotypes de Parkia biglobosa du Burkina Faso

Résumé

Le néré est un arbre fruitier sauvage des zones sèches de la savane de l'Afrique subsaharienne.
La pulpe et les graines de néré sont utilisées comme nourriture et pour générer des revenus. La pulpe du fruit, malgré sa grande consommation, n'a pas reçu jusqu'à présent une attention significative concernant sa composition biochimique.
La présente étude visait à déterminer les caractéristiques physicochimiques et la valeur nutritionnelle de la pulpe de néré collectée dans trois régions phytogéographiques du Burkina Faso et à déterminer si les attributs nutritifs et les caractéristiques de couleur variaient avec l'origine des échantillons. Les résultats ont indiqué différentes teneurs de vitamine C (1,11 ± 0,01 à 27,85 ± 0,25 mg/100g DW), et d'α-carotène (0,05 ± 0,01 à 1,38 ± 0,09 mg/100g DW).
Trois différents sucres, à savoir le fructose (2,59 ± 0,02 à 6,35 ± 0,09 g/100 g DW), le glucose (2,58 ± 0,19 à 6,31 ± 0,1 g/100 g DW) et le saccharose (9,38 ± 0,11 à 15,71 ± 0,43 g/100 g DW) ont été détectés dans la pulpe.
En ce qui concerne les caractéristiques de couleur, la valeur moyenne de l'indice jaune était la plus élevée (87,17 ± 2,23) dans l'écorégion sud-soudanienne (Saki) et la plus faible (62,51 ± 1,47) dans l'écorégion nord-soudanienne (Tewaka). Les caractéristiques de couleur de la pulpe de néré et la teneur en nutriments (à l'exception de la valeur

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du degré °Brix) ont varié de manière significative (P< .0001) entre les provenances sélectionnées. Les résultats ont montré une variation significative (P< 0,05) du pH de la pulpe, de l'acidité, des caractéristiques de couleur, de la teneur en glucose, fructose, saccharose, α-carotène et vit C entre les arbres échantillonnés, tandis qu'aucune différence significative n'a été trouvée pour le degré °Brix.

Mots clés : Parkia biglobosa, pulpe, couleur, caractéristiques nutritionnelles.

Introduction

Parkia biglobosa (Jacq.) Benth, commonly called African locust bean tree is one of the most widely used wild trees in West Africa for food, medicine and fodder. It is an indigenous tree fruit belonging to the sub-family Mimosoideae in the Leguminosae family (TIMMER et al., 1996). In several sub-Saharan African countries including Burkina Faso the fruits constitute an important part of human diets, both for rural and urban areas and constitute the most valuable product for the market (TEKLEHAIMANOT, 2004). *The quantity of fruit produced per year is ranging from 15 to 130 kg per tree (TEKLEHAIMANOT et al., 2004).* The fruit of the *P. biglobosa* tree *is non climacteric,* ovoid pod containing several seeds embedded in a yellow pulp (OLORUNMAIYE *et al.*, 2011). *African locust bean (ALB) trees are traditionally conserved by the local inhabitants due to their importance as valuable source of reliable food, especially the seeds.* Indeed, they constitute a source of income as they are the most valuable product collected from the plant. They are rich in essential amino acids (notably lysine), lipids, carbohydrates, vitamin B2, and contain bioavailable calcium (AKANDE *et al.*, 2010). The processed seeds are used as *thickening agent or* to prepare a *flavour enhancer obtained through fermentation (GUISSOU et al., 2020), a very popular condiment in many foods, called* African 'dawadawa' *(CAMPBELL-PLATT, 1980).* This is the name commonly used in Nigeria and Ghana but this condiment is also known under different local names, such as *iru* in Nigeria (SANNI *et al.,* 2000), *soumbala* in Burkina Faso (*GUISSOU et al., 2020*), *netetu* in Senegal (NDIR *et al.,* 1994), *afitin, iru* and *sonru* in Benin (AZOKPOTA *et al.,* 2006), and *kinda* in Sierra Leone. The product is part of the tradition but still very popular in West Africa, playing an important role in the diet (DAKWA *et al.,* 2005). It significantly contributes to the intake of protein, essential fatty acids, and group-B vitamins besides its flavouring attributes, and is an important source of family income (NDIR *et al.,* 1994; OUOBA *et al.,* 2003).

As for the fruit pulp, it has a sweet taste and it is used to prepare several kinds of beverages in rural areas. Recently it became a popular ingredient in ice cream products, sweets and cakes in urban areas (AKOMA *et al.,* 2001). The fruit pulp is one of the main food options in times of food scarcity and nutritional deficiency. However, the yellow dry powdery fruit pulp has not attracted much attention from the research domain. Its physicochemical characteristics and nutritional value still need to be examined. The few existing studies reported proximate composition of carbohydrates (54.98%-67.3%), crude fibre (11.75%), crude fat (1.80%-2.04%) and ash (4.18%-8.13%) (MAKALAO *et al.,* 2015; UWAEGBUTE, 1996).

In order to evaluate the nutritional and technological potential of *P. biglobosa* pulp, as a precondition to the development of the derived processed products on the local, regional and international markets, the biochemical composition and nutritional quality of pulp from different trees across Burkina Faso were characterized.

I. Materials and methods

1.1. Sample collection

Dried mature fruit samples (pods) were collected directly on trees at three areas (Sentena, Tewaka and Saki) in Burkina Faso, representing three different phytogeographical regions (South-Sahelian region, North Soudanian region and South-Soudanian region respectively). At each area fruits were collected on five trees. On each tree, between 300 and 500 dried mature pods were collected from different parts of the crown of each individual tree. The pulp was then removed from the pods packed and labelled for analysis. The study sites were located in the main ecoregions found in Burkina Faso and represent various *P. biglobosa* populations. The driest site (Sentena) had a precipitation of about 600 mm per year, and the most humid site (Saki) got more that 900 mm per year. Pods sampled were opened and the dried yellow pulp was manually extracted and stored in freezer at -20°C for analysis.

1.2. Physicochemical characteristics and nutritional value

The pulp titratable acidity was determined using the method of AOAC (2005), based on the following steps: 1 g of the pulp was suspended in 40 ml of MilliQ® water, then the mixture was homogenized using a Homogenizer-disperser (Vibrax IKA high-performance dispersing machine Ultra Turrax® IKA® Labortechnick T25Labortechnick with dispersing tool S25N-10G) at 13 500 rpm for 1 min; finally, the solution was titrated with 0.01 N sodium hydroxide using a compact titler (Automatic titrator Titrino Plus 877 : Metrohm, Switzerland).

The pH was determined using a digital pH meter (SI Analytics Lab 875P, Germany) on soluble pulp. "Brix" degree was measured using a digital refractometer (Abbe Refractometer Atago, Japan).

The contents of simple sugars (fructose, glucose and sucrose) were determined by high performance liquid chromatography (HPLC, Agilent 1100) coupled to a ESLD (Evaporative Light Scattering Detector) detector. These carbohydrates were extracted by suspending 1 g of dry pulp in 20 ml of MilliQ water in a tube. The mixture was homogenized using a Homogenizer-disperser (Vibrax IKA Labortechnick T25) at 13 500 rpm speed for 1 min and then centrifuged (15 000 rpm), at 4°C for 20 min. The supernatant was recovered and then filtered on a 0.45 μm uptidisc nylon filter in a vial. An aliquot of 20 μl of sample was injected into the Phenomenex column (RezexTM RCM-monosaccharide Ca^{2+}(8%), 300x7.8 mm) equipped with a precolumn (Rezex RCM Monosac Ca^{2+} Guard 50 x 7.8 mm) and a ESLD detector (Sedex60LT SEDERE France; Nebulization temperature 40°C, Compressed air pressure 2 bar; Gain 1). The oven temperature was fixed at 70°C. The mobile phase consists of MilliQ water with a flow rate of 0.5 ml/min. Levels of carbohydrates were quantified using external standards of D-fructose (SIGMA, USA), D-glucose (ACS ACROS, USA) and sucrose (SIGMA-ALDRICH, Switzerland). Samples were qualitatively and quantitively determined their retention times, and peak areas. The contents are expressed in g /100 g of pulp dried weight basis.

Ascorbic acid was extracted following the method described by CAMPOS et al. (2009), with slight modification. Briefly, 100 mg of the pulp were suspended in 2 ml of aqueous solution containing 0.1% of 98% (v/v) formic acid. After homogenization and centrifugation (15 000 rpm, at 4°C for 10 min), the supernatant is then filtered through a 0.45 μm PTFE filter in a vial. A quantity of 10 μl of the extract obtained was injected into the HPLC column (KINETEX polar C18, 150 × 4.6 nm, 100 A,2.6 μm) with a flow rate of 0.8 ml / min (HPLC Agilent 1200, Technologie International SARL- Morges – Switzerland). The mobile phases consist of 20vmM KH_2PO_4 buffer, pH=1.5) (phase A) and methanol (phase B). Elution was monitored at 245 nm with a diode array detector (DAD). Contents were calculated from the calibration curve established using ascorbic acid (SIGMA-ALORICH, China) as standard and are expressed in mg/100 g pulp.

The α-carotene content was determined by HPLC (Agilent 1200, Technologie International SARL-Morges – Switzerland). The extraction of α-carotene was carried out by suspending 100 mg of the pulp in 1 ml of hexane in a centrifuge tube. After homogenization (using vibrax 'VIBRAX VXR' table for 10 min) and centrifugation (15000 rpm at 4°C, for 10 min), the supernatant was dried for 35 min using a miVac concentrator (Genevac, United Kingdom). The concentrate was then dissolved into 1 ml of carrier solution (20% tetrahydrofuran/80% acetonitrile) filtered through a PTFE filter (0.45 µm). An aliquot 10 µl of the extract obtained is injected into the HPLC C18 column (Kinetex Phenomenex), 5 µm, 250x4.6 nm) with a flow rate of 0.8 ml / min. The α-carotene concentrations of the samples were calculated from the calibration curve established using α-carotene as standard. The mobile phases consist of methanol (phase A), acetonitrile (phase B) and THF (phase C). The elution gradient (phase A/phase B/phase C) was 5/95, 20/60/20, 20/80/20, 5/95 and 5/95 for 0-2, 2-20, 20-25, 25-27 and 27-35 min, respectively. Eluants were monitored at 450 nm with a DAD detector. The contents are expressed in mg / 100 g of pulp.

1.3. The colour characteristics

The colour of the pulp was measured using a colorimeter (KONICA MINOLTA CM-700d, INC. Japan) based on the CIELAB colour system (L *, a *, b *) at 8° and Xenon illumination. These parameters were measured 5 times for each sample by placing the objective of the colorimeter on a homogeneous surface of the pulp.

L *, a *, b * describe: L * (0 = black, 100 = white); a * (-a = green, + a = red); b * (-b = blue, + b = yellow), Respectively. C * and YI were calculated according to PATHARE *et al* (2013).

The intensity of the chroma colour C* is given by the equation:

$$C^* = \sqrt{a^{*2} + b^{*2}}$$

The yellowness index (YI) indicates the degree of yellowing.

$$YI = \frac{142.86\, b^*}{L^*}$$

1.4. Statistical analysis

All analyses were conducted at least in triplicate, and the data were subjected to analysis of variance (ANOVA) using the Tukey test with a confidence interval of 95 %, using the XLSTAT software. A principal component analysis (PCA) was performed using the package available in RStudio, to assess to what extent the clustering of P. biglobosa populations, based on multiple nutrient values, reflected their geography. Data are presented as mean ± standard error of the mean (SEM). A separate PCA plot showing variation in different colour characteristics has been performed.

II. Results and discussion

The pH values were ranging between 5.04 ± 0.03 and 5.50 ± 0.00 with an average titratable acidity (TA) between 0.48 ± 0.01 % and 1.14 ± 0.01 % citric acid equivalent (Table I). SE3 had significantly ($p < 0.0001$) the highest TA value (1.14 ± 0.01 %) and SA5 the lowest (0.48 ± 0.01%).

The TA values reported in the present study were lower than values reported by DAHOUENON-AHOUSSI *et al.* (2012) in previous study (2.10 ± 0.95%). The differences can be attributable to various factors. Indeed, the food characteristics can be influenced by the samples provenance, the age, the treatment before analysis, the analytical methods, the environment such as soil type, fertilizer, water or sun-light intensity (CHADARE *et al.*, 2009). For instance, MARANZ *et al.* (2004) and PARKOUDA *et al.* (2012) investigated respectively the chemical composition of different populations of the *Vitellaria paradoxa* and *Adansonia digitata* in different countries and found variability in measured parameters, both within and across populations. In the other hand TRAORÉ *et al.* (2015) demonstrated that some food nutrients contents in *Adansonia digitata* leaves vary with the provenance and the age of the tree. The variability can also be explained by the genetic factors. In Burkina Faso, for instance, a genetic variability has been identified for *Parkia biglobosa* by LOMPO *et al.* (2018). The variation found in the reported data may be explained by the fact that African locus bean (ALB) grow on different ecosystems and on a wide range of soils.

The sweetness of P. biglobosa pulp is a critical parameter that affects consumers' acceptability of the product. This characteristic is evaluated in terms of total sugar, total soluble sugar (TSS), and reducing sugars. TSS value ranged from 3.43 ± 0.02 to 3.70 ± 0.14 °Brix with TE2 displaying the highest value. The soluble carbohydrates identified in the pulp, sucrose, glucose and fructose, constituted the major ones. The sucrose content was in the range 9.38 ± 0.11 - 15.71 ± 0.43 g/100 g DW (Dry Weight). It was the predominant sugar in the pulp. The glucose content (2.58 ± 0.19-6.31 ± 0.1 g/100 g DW) was approximately equal to that of fructose (2.59 ± 0.02-6.35 ± 0.09 g/100 g DW); the highest glucose content was found in Sentena (SE2) and the lowest in Tewaka ((TE4). The glucose and fructose content were comparable to those reported by AKUBOR (2016).

The sucrose content was higher than for the other sugars, with a range of 9.38 ± 0.11-15.71 ± 0.43 g/100 g DW (Table I). Indeed, sucrose has been reported to be the predominant sugar in P. biglobosa fruit pulp and other fruits (ALABI *et al.*, 2005; LIU *et al.*, 2013).

Table I: Variation in physicochemical and nutrient properties of *Parkia biglobosa* pulp from 3 different localities in Burkina Faso.

	Site	Tree	Brix	pH	Acidity	Sucrose	Glucose	Fructose	α-Caroten (mg/100g)	Asc. Acid (mg/100g)
South-Soudanian	Saki	SA1	3.47 ± 0.08	5.29 ± 0.01	0.61 ± 0.00	12.94 ± 0.34	4.66 ± 0.18	4.68 ± 0.06	1.38 ± 0.09	5.28 ± 0.11
	Saki	SA2	3.63 ± 0.18	5.37 ± 0.04	0.57 ± 0.00	10.38 ± 0.19	6.06 ± 0.18	5.89 ± 0.12	0.47 ± 0.01	1.82 ± 0.06
	Saki	SA3	3.43 ± 0.02	5.09 ± 0.41	0.81 ± 0.00	10.58 ± 0.43	4.45 ± 0.10	4.80 ± 0.13	0.43 ± 0.01	3.45 ± 0.13
	Saki	SA4	3.62 ± 0.17	5.50 ± 0.00	0.81 ± 0.01	11.29 ± 0.28	4.90 ± 0.23	5.55 ± 0.14	0.59 ± 0.02	2.06 ± 0.10
	Saki	SA5	3.51 ± 0.07	5.19 ± 0.04	0.48 ± 0.01	13.63 ± 0.10	3.45 ± 0.05	3.12 ± 0.04	0.05 ± 0.01	7.84 ± 0.65
		Pr > F	**0.05**	**0.02**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
North Soudanian	Tewaka	TE1	3.60 ± 0.14	5.36 ± 0.02	0.88 ± 0.00	13.13 ± 0.28	4.08 ± 0.11	4.55 ± 0.12	0.17 ± 0.01	2.22 ± 0.12
	Tewaka	TE2	3.70 ± 0.14	5.31 ± 0.03	0.86 ± 0.00	15.71 ± 0.43	3.31 ± 0.29	3.64 ± 0.09	0.27 ± 0.01	3.08 ± 0.06
	Tewaka	TE3	3.60 ± 0.00	5.34 ± 0.01	0.76 ± 0.00	9.38 ± 0.11	5.64 ± 0.11	6.35 ± 0.09	0.24 ± 0.01	1.11 ± 0.01
	Tewaka	TE4	3.53 ± 0.08	5.35 ± 0.02	0.64 ± 0.00	15.47 ± 0.22	2.58 ± 0.19	2.59 ± 0.02	0.36 ± 0.01	1.93 ± 0.14
	Tewaka	TE5	3.56 ± 0.05	5.31 ± 0.01	0.67 ± 0.00	13.29 ± 0.07	4.12 ± 0.01	4.23 ± 0.05	0.62 ± 0.01	3.23 ± 0.02
		Pr > F	**0.13**	**0.00**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
South-Sahelian	Sentena	SE1	3.47 ± 0.08	5.04 ± 0.03	0.70 ± 0.00	13.59 ± 0.12	3.76 ± 0.01	3.80 ± 0.05	0.24 ± 0.02	1.96 ± 0.08
	Sentena	SE2	3.53 ± 0.16	5.14 ± 0.00	0.56 ± 0.00	11.87 ± 0.17	6.31 ± 0.1	6.27 ± 0.07	0.55 ± 0.02	27.85 ± 0.25
	Sentena	SE3	3.57 ± 0.04	5.22 ± 0.00	1.14 ± 0.01	10.72 ± 0.13	2.89 ± 0.05	4.36 ± 0.05	0.25 ± 0.01	3.91 ± 0.08
	Sentena	SE4	3.53 ± 0.16	5.38 ± 0.01	0.59 ± 0.00	14.16 ± 0.27	5.15 ± 0.04	5.01 ± 0.06	0.10 ± 0.01	17.33 ± 0.10
	Sentena	SE5	3.47 ± 0.08	5.42 ± 0.00	0.59 ± 0.00	11.63 ± 0.08	5.63 ± 0.07	5.66 ± 0.04	0.50 ± 0.02	6.58 ± 0.49
		Pr > F	**0.59**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
		Pr > F	0.02	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001

P. biglobosa pulp had significantly different levels of α-carotene and ascorbic acid (vitamin C) ranging from 0.05 ± 0.01 to 1.38 ± 0.09 mg/ 100g DW and 1.11 ± 0.01 to 27.85 ± 0.25 mg/ 100g DW, respectively (Table I). SA1 in Saki had the highest α-carotene content (1.38 ± 0.09 mg/ 100g DW) while SE1 in Sentena had the highest vitamin C content (27.85 ± 0.25 mg/ 100g DW). The large variation in the reported data may be due to various factor as discussed earlier.

The vitamin C contents reported in the present study were lower compared with values (208.71 ±0.19 mg/ 100g DW) reported by MAKALAO *et al.* (2015) or those (32±0.01) reported by AHODEGNON *et al.* (2018) but much higher than those (0.005-0.006) reported by OLUJOBI (2012).

The scores of the first two principal components for pulp from fifteen ALB (three different localities) related to the pulp physical and nutrient characteristics revealed no separate classes (Fig. 1).

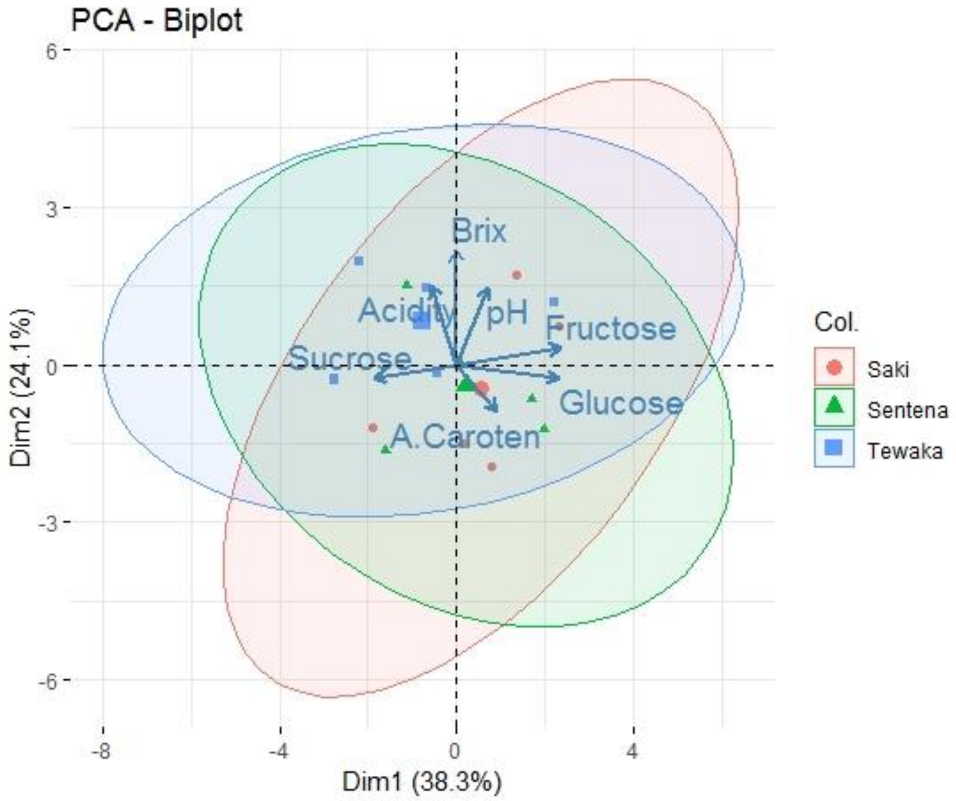

Figure 1: Principal component analysis plot showing variation in different physicochemical and nutrient properties of *Parkia biglobosa* fruit pulp, collected from three localities in Burkina Faso. (Saki, Sentena, Tewaka).

The first two principal components took into account 62.4% (PC1 = 38.3% and PC2 = 24.1%, respectively), of the total variation.

The clustering depended mostly by the variety of entire colour characteristics properties but not individual parameter. Therefore, the three provenances could not be effectively specified by PCA.

PC1 was highly contributed by Fructose (0.93), Glucose (0.93) and Sucrose (0.74). PC2 was mainly correlated to °Brix (0.93).

The colour characteristics directly affect the appearance of a food item and the consumer acceptability Significant differences in colour characteristics of different P. biglobosa pulp samples ($P < 0.0001$) were observed among trees for the following parameters: L*, a*, b*, C* and YI (Table II). Possible explanations given for these differences are the carotenoid content that are linked to several factors (environmental and genetics).

Lightness (L*) values were in the range of 75.44±2.26 and 83.77±0.81.

The pulp of the SA5 displayed the highest value for L*, while SE2 had significantly higher (P < 0.0001) b* and C* value among the pulps. SA4 had significantly higher (P < 0.0001) a* and YI. The variation in the reported data may be due to various factor such as environmental and/or genetics as discussed earlier. Principal component analysis (PCA) was applied to observe any possible clusters emerging from colour characteristics of P. biglobosa pulp samples.

Table II. Variation in colour characteristics of 15 *Parkia biglobosa* pulp samples from 3 different localities in Burkina Faso.

	Site	Tree	L*	a*	b*	C*	YI
South-Soudanian	Saki	SA1	79.4 ± 1.3	6.7 ± 0.5	44.6 ± 0.8	45.1 ± 0.8	80.2 ± 2.6
	Saki	SA2	82.1 ± 1.7	6.4 ± 0.5	47.8 ± 0.1	48.2 ± 1	83.2 ± 2.5
	Saki	SA3	77.8 ± 4.6	6.8 ± 0.7	44.6 ± 2.2	45.1 ± 2.2	82 ± 4.8
	Saki	SA4	78.4 ± 0.6	8.1 ± 0.5	47.8 ± 1.1	48.5 ± 1.1	87.2 ± 2.2
	Saki	SA5	83.8 ± 0.8	4.6 ± 0.2	42.6 ±	42.8 ± 1	72.6 ± 1.8
		Pr > F	**0.00**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
North Soudanian	Tewaka	TE1	76.9 ± 3.4	4.7 ± 0.3	44 ± 0.7	44.7 ± 0.7	81.9 ± 2.8
	Tewaka	TE2	75.4 ± 2.	7.61 ± 0.2	40.9 ± 0.8	41.6 ± 0.8	77.5 ± 1.9
	Tewaka	TE3	82.8 ± 1.1	5.5 ± 0.1	43.8 ± 0.5	44.1 ± 0.5	75.5 ± 0.9
	Tewaka	TE4	77.3 ± 5.3	5.2 ± 0.5	35.1 ± 0.1	35.4 ± 1	64.9 ± 3.6
	Tewaka	TE5	80.7 ± 1.9	5.3 ± 0.4	35.3 ± 0.6	35.7 ± 0.6	62.5 ± 1.5
		Pr > F	**0.01**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
South-Sahelian	Sentena	SE1	79.2 ± 0.6	7.1 ± 0.2	42.7 ± 0.6	43.3 ± 0.5	77 ± 0.7
	Sentena	SE2	80.5 ± 0.5	7.4 ± 0.2	48.7 ± 0.6	49.2 ± 0.6	86.4 ± 1.4
	Sentena	SE3	81.1 ± 0.6	6.2 ± 0.2	40.0 ± 1.1	40.5 ± 1.1	70.5 ± 2.0
	Sentena	SE4	83.4 ± 0.9	4.9 ± 0.2	40.2 ± 0.4	40.5 ± 0.4	68.9 ± 1.2
	Sentena	SE5	82.6 ± 1.1	6.1 ± 0.1	44.7 ± 0.5	45.2 ± 0.5	77.4 ± 1.8
		Pr > F	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**
		Pr > F	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**	**< 0.0001**

The scores of the first two principal components for pulp from fifteen ALB (three different localities) related to the pulp colour did not identify separate classes (Fig. 2) . Pulp from TE5 and TE4 have particular characteristics. the pulps of the two trees are outside the intersection of the three ellipses.

The first two principal components took into account 98.4% (PC1 = 70% and PC2 = 28.4%, respectively), of the total variation. The clustering can be explained by the variety of entire colour characteristics properties but not individual parameter. Therefore, the three provenances could not be effectively specified by PCA. PC1 was highly contributed by a* (0.89), b* (0.99), C* (0.99) and YI (0.99). PC2 was mainly correlated to L* (0.99).

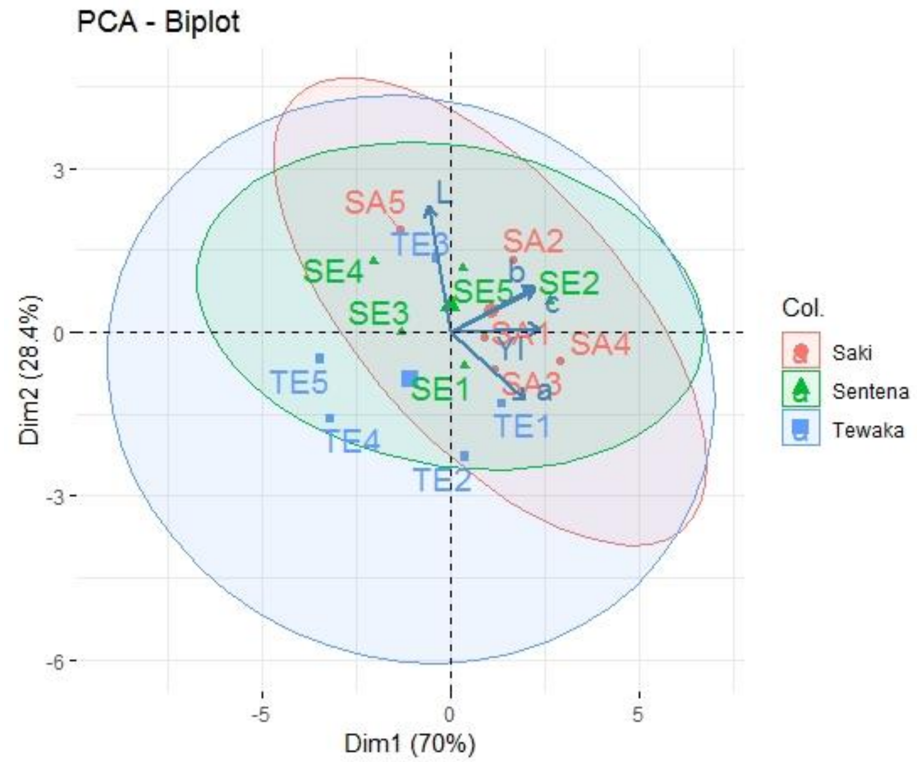

Figure 2: Principal component analysis plot showing variation in different colour characteristics of *Parkia biglobosa* fruit pulp, collected from three localities in Burkina Faso (Saki, Sentena, Tewaka).

Conclusion

The present study illustrated how colour characteristics varied considerably in *P. biglobosa'* s pulp samples, both across different sites and among tree individuals sampled in the same location. More specifically, this study revealed a wide variation in the sucrose, glucose fructose, α-carotene, and vitamin C levels. This study open doors for further investigation, on the stability of colour parameters and associated nutritional values, in order monitor these factors in the management of *P. biglobosa'* s pulp for food processing.

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Acknowledgment

The government of Burkina Faso is thanked for the mobility grant which enabled analyses to be carried out at ESA/USC GRAPPE in France. The Austrian Development Agency through the project on "Nutrition-sensitive forest restoration to enhance the capacity of rural communities in Burkina Faso to adapt to change" (2016-2019), led by Bioversity International (Italy) is thanked for facilitating the sample collection.