Research Article

Impact of mineral and organic absorbent during the discoloration of avocado oil by comparing with olive oil

Orléans Ngomo [a,b.] , Joseph Sieliechi [b.] , Etienne Dongo [a.]

[a]Laboratory of Natural Substances and Environment; University of Yaounde I-Cameroon

[b]Laboratory of actives substances and pollution; University of Ngaoundere-Cameroon

Corresponding author: NGOMO Orléans: orleansn@yahoo.*fr*

Abstract

Avocado is a versatile and valuable product. Its oil is comparable to olive oil in terms of nutritional quality. It can also be used in cosmetics, in particular, in soaps, shampoos and lotions. Despite all these important attributes that avocado has, it is highly perishable and coupled with the lack of farm-to-market roads, a lot of it is lost after harvest during the peak season. The introduction of methods that will transform avocado to products with a long shelf life and added value will go a long way to solving the problem of post-harvest losses and poverty. One of these methods is the production of avocado oil. In addition, in order to reduce the colour of the pigments without altering their quality, discoloration tests were carried out by adsorption on bleaching grounds (a montmorillonite, a kaolinite and activated carbon). The colour intensities of the oils before and after adsorption were determined using two complementary methods: a UV-Vis spectrophotometer and a Konica Minolta spectrophotometer CM-5. The UV-Vis spectrophotometer show that the activated carbon has a best fixing capacity of the pigments; According to the Colorimetric parameters (CIE-Lab) the coordinates L* a* b* that showed brightness (L*) of the avocado oil was half of the olive oil (41.13±0.02 vs 84.85±0.02). The activated carbon was better in fixing the red (a*) (4.99±0.01vs 15.73±0.01 before adsorption) and yellow (b*) (63.71±0.09 vs 70.07±0.09 before adsorption) pigments, while the other two adsorbents have very little influence on the red colour of avocado oil.

***Keywords**: Avocado oil, olive oil, discoloration, adsorption*

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Résumé

L'avocat est un produit versatile et de grande valeur. Son huile est comparable à huile d'olive en terme de qualité nutritionnelle ; elle peut également être utilisée en cosmétique en occurrence dans les savons, champoings et lotions. En pleine saison, l'on fait face à une abondance des avocats dans les zones de production qui sont très souvent enclavées ; c'est ainsi que face aux difficultés de transport et les routes peu praticables pour l'importation, l'on se retrouve en train de perdre de très importantes quantités d'avocats après les récoltes. Or la production d'huile d'avocats permettrait de réduire les pertes post récolte, réduirait le chômage et permettrait de lutter contre la pauvreté après la vente des huiles extraites. De plus, dans le but de réduire les pigments colorés, des tests de décolorations effectués par adsorption sur des terres décolorantes (une montmorillonite en provenance de Maroua, une kaolinite en provenance de Douala et le charbon actif) sont effectués. Les couleurs des huiles mesurées avant et après adsorption à l'aide deux appareils complémentaires : Le spectrophotomètre UV-Vis et du Konica Minolta spectrophotomètre CM-5 montrent. Les analyses spectrophotométriques UV-Vis montrent que c'est le charbon activé qui présente la meilleure adsorption des pigments ; D'après les coordonnées L*a*b*, la clarté de l'huile d'avocat est pratiquement la moitié de celle de l'huile d'olive (41,13±0,02 contre 84,85±0,02), le charbon activé fixe mieux les pigments rouges (a*) (4,99±0,01 contre 15,73±0,01 avant adsorption) et jaunes (b*) (63,71±0,09 contre 70,07±0,09 après adsorption), tandis que les deux autres adsorbants influencent très peu sur la coloration des huiles.

Mots clés *: huile d'avocat, huile d'olive, décoloration, adsorption*

Introduction

Avocado (*Persea americana*) is the fruit of avocado tree that belongs to the family of Lauraceae. It originated from Mexico and was ûrst cultivated according to FAO 2004. It is now grown worldwide (Dreher and Davenporta, 2013; Adodo, 1995). Avocado is considered as one of the main tropical fruits, as it contains fat-soluble vitamins, rich in unsaturated fatty acids, fiber, vitamins B and E, carotenoids and other nutrients which are less common in other fruits, besides high levels of protein and potassium. Avocado pulp contains variable oils which have been used traditionally for a number of health-related indications. Most varieties have high oil content with a wide range of 3–30% (Elhadi, 2012). Because of its high polyphenol content, Deepti et al. (2019) investigated the potential antioxidant and anticancer effects of a coloured avocado seed extract. Avocado oil is also widely used in the pharmaceutical and cosmetics industry for half a century (Haendler, 1965). It is beneficial for skin, face, hair and high balmy and cicatrizing qualities. For its use in cosmetics, crude avocado oil is further processed (refined, bleached and deodorized). The resulting oil is pale yellow (instead of green) and has little remaining avocado odour or taste. The refined oil is used in skin-care products since it is rapidly absorbed by the skin, and has sunscreen properties (Woolf et al., 2009). Avocado oil for salad dressings should be submitted to winterization to eliminate the saturated triglycerides, which can cloud the oil stored at low temperatures (Salgado et al., 2008). Besides the possibility of using pure avocado oil as a substitute for olive oil, the combination of olive oil and avocado oil to replace olive oil mixtures usually offered by the internal market is a promising alternative to reduce costs of some countries importing olive oil (Duarte et al., 2016). According to the consumption of Avocado between 1998 and 2000 in different countries, Cameroon was the 10th (FAOSTAT, 2002). As part of the development of Cameroonian agriculture and the transformation of produce to value-added products, many projects in gestations consist in the production of avocados and avocado oil by the peasant families. This is done with the aim of transforming surplus avocados into oil by implementing an oil extraction unit that improves and valorizes the small local production of avocados to develop family farming. The oils from this extraction retain the yellow-green colour of the pulp. A technique for clarifying oils without altering the quality consists in fixing its pigments on a solid support by adsorption. This work was carried out to investigate the effect of adsorbent on quality of discolored oil. three adsorbents have been chosen for this purpose. A sample of clay originated from Maroua in the Far North region of Cameroon characterized as montmorillonite with large specific surface, another from Douala in the Littoral characterized as kaolinite (Ngomo et al., 2014) and industrial activated carbon that serves as a reference are used as support adsorbent for this work. Olive oil is also set as a model in the comparison of the colour of the avocado oil before and after adsorption on different supports.

Materials and Methods

The biological material is principally avocado from Ngaoundere in the region of Adamaoua - Cameroon. The pulp was separated manually from the peel and seed. These agro-industrial by-products were dried on the sun for seven hours before hand pressing of avocado oil. The olive oil Cora used as a reference was purchased from a local market.

The mineral material that were used are 2:1 clay (montmorillonite) from Maroua in the Far North Region of Cameroon, 1:1 clay (kaolinite) from Douala in the Littoral and an industrially activated carbon that served as a reference.

For adsorption, 20ml of avocado oil was mixed with 2g of adsorbent for one hour of agitation at

25°C. After that, the mixture was centrifuged at 4000rpm for 25 minutes to separate the oil from the adsorbent.

The two pieces of laboratory equipment used to determine color are the UV-Vis Spectrophotometer and the Konica Minolta, CM-5 spectrophotometer.
The adsorption spectra were recorded on a Perkin-Elmer (Lambda EZ 210) double beam UV-Visible Spectrophotometer equipped with a Xenon lamp at 450W. The excitation wavelengths were: 416, 439 and 469 nm.

The colour measurements were carried out by a Konica Minolta Chroma Meter CM-5, using D65 illuminant and 10°standard observers, according to the Commission Internationale de l'Eclairage (CIE) for the Colorimetric parameters (CIE-Lab.). The brightness of the CIE data was expressed as L*, changing from 0 (black) to 100 (white) while the chromatic characteristics of coloured products were also expressed as a*(+red, -green) and b*(+yellow, -blue) (Hajjaji et al., 2013).

For each of these measurements we have made two replications. Then we use the variance to Analyze of many factors (ANOVA) for statistical analysis; for this analysis, the number of completes subjects is 10 for each of three parameters to analyze. Tests and graphics obtained will determine the statistically significant factors and the interactions between the factors.

Results and Discussion

The absorbance curves of the crude avocado oil, the oil after adsorption of the pigments on the Maroua clay, the Douala clay, activated carbon and the olive oil, for the wavelength for 250 nm to 700 nm are presented in Figure 1.

The absorbance curves of the crude avocado oil, the oil after adsorption of the pigments on the Maroua clay, the Douala clay, activated carbon and the olive oil is represented on figure1. This figure presented characteristic peaks of carotenoids clearly visible at 416nm, 439nm and 467nm. Further, visible peaks were

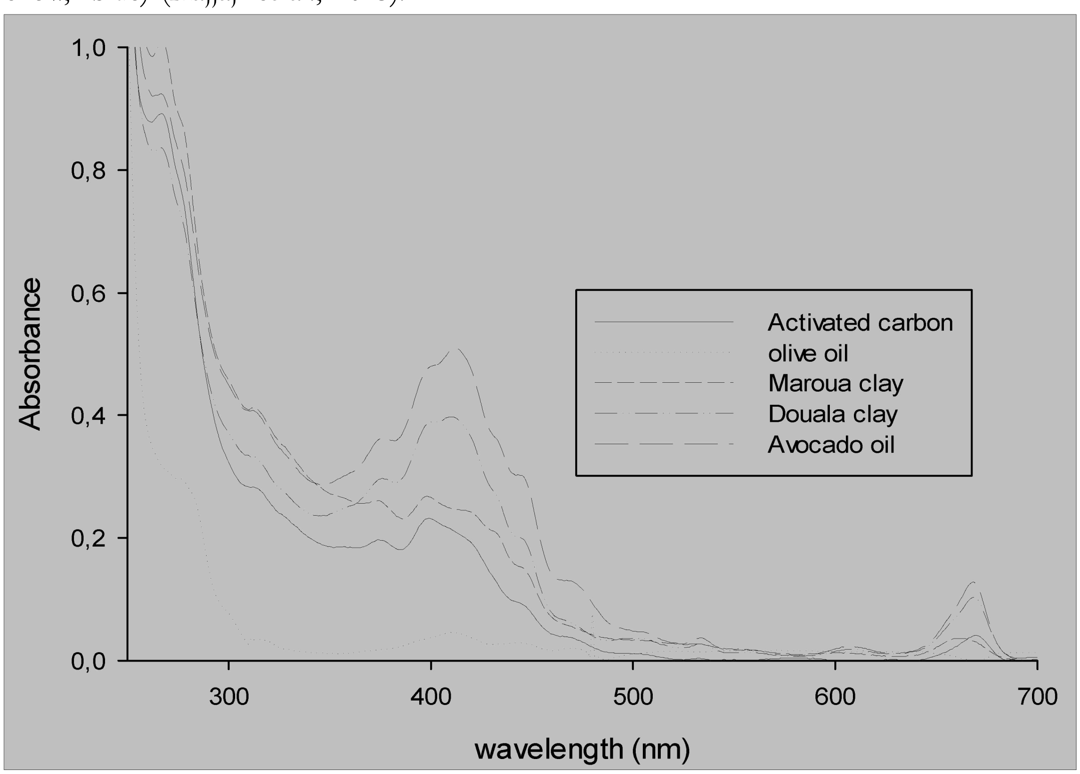

Figure1. Absorption spectra of avocado at three different excitation wavelengths (416, 439 and 469 nm)

observed at 669nm corresponding to residual chlorophyll.

All the curves were almost superimposable. The intensity of the peaks led to the conclusion that the activated carbon has a best fixing capacity of the pigments, followed by the clay from Maroua and finally that from Douala.

From the economic point of view, activated carbon, which is expensive for the refining industries, may be partially substituted by Maroua clay because of the oils from these adsorbents are quite similar to olive oil.

In fact, the Maroua clay is swollen montmorillonite, style 2:1, with a large specific surface area that has a great adsorption capacity. On the contrary, the Douala clay is swollen kaolinitic with a small specific surface area for adsorption. and therefore, adsorbs less (Ngomo et al., 2014).

The brightness and chromatic characteristics of the five treatments: Avocado oil, Avocado oil after adsorption on Maroua clay, Avocado oil after adsorption on Douala clay, Avocado oil after adsorption on activated carbon and Olive oil estimated by measuring the L*a*b* coordinates with duplication of each parameter is shown on the table 1.

Table 1. Brightness and chromatic characteristics of the five treatments: Avocado oil, Avocado oil after adsorption on Maroua clay, Avocado oil after adsorption on Douala clay, Avocado oil after adsorption on activated carbon and Olive oil estimated by measuring the L*a*b* coordinates

	L*	a*	b*
Avocado oil	41.14	15.73	70.17
	41.12	15.71	70.01
On Maroua clay	60.79	14.64	95.30
	60.78	14.63	95.98
On Douala clay	48.97	15.55	81.80
	48.91	15.52	81.62
On activated Carbon	54.80	5.00	63.73
	54.77	4.98	63.67
	84.85	3.54	116.90
Olive oil	84.85	3.43	116.81

The colorimetric measurements revealed that the avocado oil containing pigments had the highest black colour given by the decrease of brightness, and also by the improvement of red.

The data were subjected to statistical analysis(ANOVA) to determine the statistically significant factors and the interactions between the factors is shown on the table 2.

*Table 2. The variance Analyze (ANOVA) of Avocado oil, Avocado oil after adsorption on Maroua clay, Avocado oil after adsorption on Douala clay, Avocado oil after adsorption on activated carbon and Olive oil estimated by measuring the L*a*b* coordinates for statistical difference.*

	L*	a*	b*
Avocado oil	41.13±0.02[a]	15.73±0.01[e]	70.07±0.09[b]
On Maroua clay	60.79±0.02[d]	14.63±0.01[c]	95.17±0.09[d]
On Douala clay	48.96±0.02[b]	15.54±0.01[d]	81.72±0.09[c]
On activated Carbon	54.79±0.02[c]	4.99±0.01[b]	63.71±0.09[a]
Olive oil	84.85±0.02[e]	3.44±0.01[a]	116.87±0.09[e]

As shown on table 2, there are different super-indexes in column indicating statistical differences betwen corresponding parameter between the oils ($p<0.05$ ANOVA and Fisher).

The Multifactor ANOVA procedure performs a multivariate analysis of variance for brightness (L*). It displays various tests and graphs to determine the factors that have a statistically significant effect on brightness (L*). It also tests whether there are significant interactions between factors. The Fisher tests in the ANOVA table allow us to identify significant factors. For each significant factor, the multiple range tests tell us which means are significantly different from each other. Graphs of means and interactions help us interpret significant effects. The residuals plots help us check whether or not the assumptions required for the analysis of variance are being met.

Table 3. Analysis of variance for brightness (L). – Sum of square for type III*

Sources	*Sum of squares*	*Ddl*	*Mean square*	*F*	*Probability*
MEANS EFFETS					
SAMPLES	2211.29	4	552.824	1105647.43	0.0000
RESIDUE	0.0025	5	0.0005		
TOTAL (CORRECTED	2211.3	9			

All F are based on the mean squared residual error.

The ANOVA results shown on table 3 decompose the variability of brightness (L*) into contributions due to various factors. Since the type III sum of squares (default) was chosen, the contribution of each factor is measured after eliminating the effects of other factors. The values of the probabilities test the statistical significance of each factor. Since a value of the probabilities is less than 0.05, this factor has a statistically significant effect on brightness (L*) at the 95.0% confidence level.

Table 4. Multiple range tests for brightness (L) by different samples; Method: 95.0 % LSD*

	Effective	*Mean MC*	*Error MC*	*Homogeny groups*
Avocado oil	2	41.13	0.0158114	X
On Maroua clay	2	48.94	0.0158114	X
On Douala clay	2	54.785	0.0158114	X
On activated Carbon	2	60.785	0.0158114	X
Olive oil	2	84.85	0.0158114	X

Contrast	*Sig.*	*Difference*	*+/- limits*
Avocado oil - Maroua clay	*	-19.655	0.0574801
Avocado oil - Douala clay	*	-7.81	0.0574801
Avocado oil - activated Carbon	*	-13.655	0.0574801
Avocado oil - Olive oil	*	-43.72	0.0574801
Maroua clay - Douala clay	*	11.845	0.0574801
Maroua clay - activated Carbon	*	6.0	0.0574801
Maroua clay - Olive oil	*	-24.065	0.0574801
Douala clay - activated Carbon	*	-5.845	0.0574801
Douala clay - Olive oil	*	-35.91	0.0574801
activated Carbon - Olive oil	*	-30.065	0.0574801

* indicates a statistically significant difference.

Multiple range tests for brightness (L*) on different samples uses the multiple comparison procedure to determine which means are significantly different from each other. The method currently used to discriminate between means is Fisher's Minimum Significant Difference (LSD) procedure. With this method, there is a 5.0% chance of saying that each pair of means is significantly different when the true difference is 0.

Table 5. Multiple range tests for red (a) by different samples; Method: 95.0 % LSD*

	Effective	*Average MC*	*Error MC*	*Homogeny group*
Avocado oil	2	3.44	0.0104881	X
On Maroua clay	2	4.99	0.0104881	X
On Douala clay	2	14.635	0.0104881	X
On activated Carbon	2	15.535	0.0104881	X
Olive oil	2	15.72	0.0104881	X

Contrast	*Sig.*	*Difference*	*+/- limits*
Avocado oil - Maroua clay	*	1.085	0.038128
Avocado oil - Douala clay	*	0.185	0.038128
Avocado oil - activated Carbon	*	10.73	0.038128
Avocado oil - Olive oil	*	12.28	0.038128
Maroua clay - Douala clay	*	-0.9	0.038128
Maroua clay - activated Carbon	*	9.645	0.038128
Maroua clay - Olive oil	*	11.195	0.038128
Douala clay - activated Carbon	*	10.545	0.038128
Douala clay - Olive oil	*	12.095	0.038128
activated Carbon - Olive oil	*	1.55	0.038128

* indicates a statistically significant difference.

Table 5 uses the multiple comparison procedure to determine which means are significantly different from each other. The upper part of this table displays the estimated differences between the pairs of means. A star has been placed next to 10 pairs, indicating that these pairs have statistically significant differences at the 95.0% confidence level. At the top of this page, 5 homogeneous groups are identified using columns of X. In each column, the levels containing X form a group of means within which there are no statistically significant differences. The method currently used to discriminate between means is Fisher's Minimum Significant Difference (LSD) procedure. With this method, there is a 5.0% chance of saying that each pair of means is significantly different when the true difference is 0.

Table 6. Table of least squares means for red (a) with 95.0% confidence intervals*

level	Effective	average	Error type	Limit inf.	Limit sup.
GENERAL AVERAGE	10	10.864			
Avocado oil	2	15.72	0.0104881	15.693	15.747
On Maroua clay	2	14.635	0.0104881	14.608	14.662
On Douala clay	2	15.535	0.0104881	15.508	15.562
On activated Carbon	2	4.99	0.0104881	4.96304	5.01696
Olive oil	2	3.44	0.0104881	3.41304	3.46696

This table 6 gives the means of red (a*) for each level of the factors. It also indicates the standard error for each mean, which is a measure of its variability in the sample. The two rightmost columns give the 95.0% confidence intervals for each of the means.

The Multifactor ANOVA of yellow (b*) procedure performs a multivariate analysis of variance for yellow (b*). It displays various tests and graphs to determine which factors have a statistically significant effect on yellow (b*). The F tests in the ANOVA table allow us to identify significant factors. For each significant factor, the multiple range tests tell us which means are significantly different from each other.

Table 7. Analysis of variance for yellow (b)– Sum of square for type III*

Source	Sum of squares	Ddl	Mean Square	F	Probability
MEANS EFFETS					
SAMPLES	3606.28	4	901.569	52386.34	0.0000
RESIDUE	0.08605	5	0.01721		
TOTAL (CORRECTED)	3606.36	9			

All F are based on the mean squared residual error.

The ANOVA table decomposes the variability of yellow (b*) into contributions due to various factors. Since the type III sum of squares (default) was chosen, the contribution of each factor is measured after eliminating the effects of other factors. The values of the probabilities test the statistical significance of each factor. Since a probability value is less than 0.05, this factor has a statistically significant effect on yellow (b*) at the 95.0% confidence level.

Table 8. Multiple range tests for yellow (b) by different samples*

	Effective	Mean MC	Error MC	homogeny group
activated Carbon	2	63.7	0.0927631	X
Avocado oil	2	70.09	0.0927631	X
Douala clay	2	81.71	0.0927631	X
Maroua clay	2	95.14	0.0927631	X
Olive oil	2	116.855	0.0927631	X

Contrast	Sig.	Difference	+/- limits
Avocado oil - Maroua clay	*	-25.05	0.337228
Avocado oil - Douala clay	*	-11.62	0.337228
Avocado oil - activated Carbon	*	6.39	0.337228
Avocado oil - Olive oil	*	-46.765	0.337228
Maroua clay - Douala clay	*	13.43	0.337228
Maroua clay - activated Carbon	*	31.44	0.337228
Maroua clay - Olive oil	*	-21.715	0.337228
Douala clay - activated Carbon	*	18.01	0.337228
Douala clay - Olive oil	*	-35.145	0.337228
activated Carbon - Olive oil	*	-53.155	0.337228

* indicates a statistically significant difference.

This table 8 uses the multiple comparison procedure to determine which means are significantly different from each other. The upper part of this table displays the estimated differences between the pairs of means. A star has been placed next to 10 pairs, indicating that these pairs have statistically significant differences at the 95.0% confidence level. At the top of this, 5 homogeneous groups are identified using columns of X. In each column, the levels containing X form a group of means within which there are no statistically significant differences.

Finally, by comparison of brightness (coordinate L*), olive oil is the clearest, followed by the oil after adsorption on Maroua clay, after carbon clay and Douala clay; and finally, pure avocado oil has a brightness practically the half of the olive oil. We can say that adsorption improve the clarity of avocado oil.

By comparison of redness (coordinate a*), avocado oil before adsorption, after adsorption on Maroua and Douala clay have the highest values through that olive oil and oil after adsorption on activated carbon represented practically the quarter of preceding values (about 4).

The comparison of yellow (coordinate b*), olive oil is about quite similar of the avocado oil after activated carbon adsorption. The three other sample are middle

However, by taking the tree parameters (L*, a* and b*) of each sample, there is no fair difference between maximum and minimum of each parameter for the fifth studied cases, the standard deviation is very soft.

Conclusion

In this study that the aim was appreciate the effect of adsorbent on color of avocado oil; we can say that activated carbon shows the best discoloration, followed by the Maroua clay, according the colourimetric parameters of the oils. The chromatic characteristics show that Maroua clay yields the best brightness, near to olive oil; it can be used as economic and natural adsorbent for clarification of avocado oil.

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