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Short Communication
Spectrophotometric Quantification of Some Pigments in Mango Pulp (*Mangifera mindica* L.) Powder

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Abstract

Background and Objective: Mango (*Mangifera indica* L.) is among tropical fruits the most consumed through the world. It's appreciated not only for its taste but also for its nutritional quality. This work was carried out to investigate the mango pulp powder composition of one mango cultivar at the ripening stage in relation to five pigments with antioxidant potential. The antiradical activity was also estimated. **Materials and Methods:** Pigments have been quantified by spectrophotometry (flavonols, carotenoids, lycopene, anthocyanins and chlorophyll), whereas the antiradical activity has been determined by DPPH test. **Results:** Results show divergent contents in different pigments, which can be classified in descending order in: flavonols>lycopene>anthocyanins>carotenoids>chlorophyll; accompanied by an important antiradical activity (92.12%, with an IC_{50} of 109.75 mg mL^{-1}). **Conclusion:** Given the high levels of bioactive molecules in mango powder drying is a technique to be encouraged.

Key words: Mango pulp powder, pigments, antiradical activity

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Mango (*Mangifera indica* L.) is one of the most important tropical fruits commercialized and consumed worldwide fresh or processed having an attractive color and distinct taste and aroma[1]. Mango is not only delicious but also its constitute a rich source of nutrient such as minerals, vitamins, dietary fiber and bioactive molecules such as carotenoïds (vitamin A) that can be used to fight against vitamin A deficiency, a serious problem in developing countries, ascorbic acid (vitamine C), lycopene which has attracted quite great interest among medical researchers. Thus, claims have been made that lycopene may be beneficial in diseases such as cancer and coronary heart disease, as well as other chronic conditions[2] and phenolic compounds which exhibit an antioxidant activity because of their property to interact with different free radicals species by a reducing action. The mechanisms to capture free radicals are divided into two types. In both cases, they are blockers of the initial stage in the oxidative process of lipid or protein[3] and many others which are vital to normal human growth, development and health[4-5]. According to Belem *et al.*[6], a half a mango is enough to cover all the daily requirements of provitamin A and more than 66% of the total recommended for vitamin C.

Mango like all fruit is fat, sodium and cholesterol-free[7]. Despite the nutritional and economic importance of the mango and the food interest that the people give it, it is also highly perishable, soon after ripening, the fruit starts decaying and quickly becomes unfit for consumption, thus its use is limited by huge post-harvest losses since fresh mango can be stored for less than 10 days at room temperature. It does not tolerate freezing and browns under prolonged refrigeration. A real problem of conservation therefore arises. Processing technologies from pulp to juice and nectars exist as well as the production of jellies and jams[8-9]. It is in a major concern of the rapid deterioration of the fresh mango that this work aims to study the possible transformation of the fresh mango pulp into powder and to determine the content of some bioactive molecules (pigments) as well as of antiradical activity.

MATERIALS AND METHODS

Sample preparation: The study focused on the mango variety called "Green Mango", one of the mango varieties widely cultivated in Mali. It was purchased from local vendors on August 2018 in the city of Bamako (Malian capital) located in the south of the country, an area well known for the export of this fruit from different regions. The transformation of the fresh mango into powder is carried out, after washing, drying and grinding, according to the diagram illustrated in Fig. 1. Mango samples are shown in the Fig. 2a-c. The duration of the work was of 5 months, from August-December, 2018.

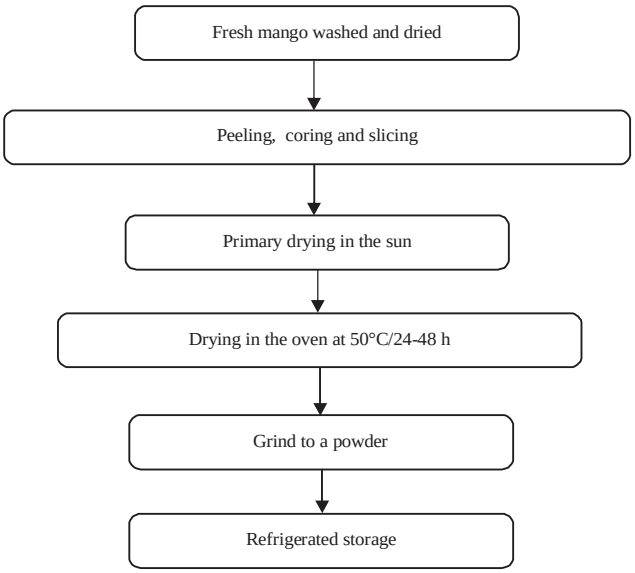

Fig. 1: Transformation of the fresh mango into powder

Preparation of the extracts: The extract was prepared as prescribed by Derradji-Benmeziane *et al.*[10] with slight modifications. Briefly, 1 g of mango powder was extracted with 5 mL of aqueous methanol 80% (v/v) for 40 min at room temperature. The mixture was filtered and stored under refrigerated conditions until used.

Quantification of antioxidants: The amount of total carotenoid and lycopene was determined using the method of Sass-Kiss *et al.*[11]. The carotenoïds were extracted in mixture of 10 mL of hexane-acetone-ethanol, 2:1:1, v:v:v followed by a second extraction with 10 mL of hexane, β-carotene was used as standard. The concentration of lycopene was determined from the absorbance at 472 nm using a molar extinction coefficient[12] (e) of 3450 L/mol/cm. As for anthocyanins and flavonol, they were extracted according to the procedure reported by Ganjewala *et al.*[13]. Briefly, 0.5 g of mango pulp powder was extracted with 10 mL of a mixture methanol-0.1 mL of HCl, after 30 min, the solution was centrifuged at 4000 rpm 20 min^{-1} to 0.1 mL of the supernatant was added 0.9 of the mixture (methanol-HCl). The concentration of anthocyanin was determined from the absorbance at 530 nm using a molar extinction coefficient (e) of 38,000 $L*mol^{-1}*cm^{-1}$, that of the flavonol glycosides at 360 nm (e) 520,000 $L* mol^{-1}*cm^{-1}$ determined from a pure

Fig. 2(a-c): Mango sample, (a) Fresh mango, (b) Dried mango slices and (c) Mango pulp powder

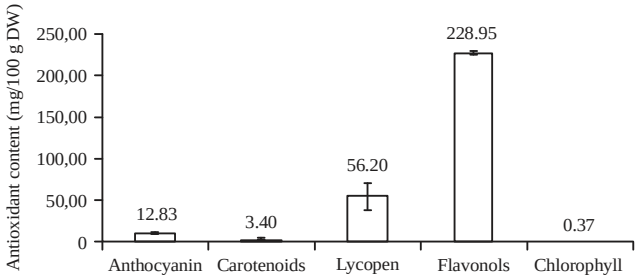

Fig. 3: Content of some mango powder pigments
Result are expressed as mg/100 g DW, vertical bars represent standard deviations

sample of quercetin 3-glucoside). The chlorophyll content was determined after dissolution in cyclohexane and measurement of absorbance at 670 nm using a molar extinction coefficient (e) of 613 L* mol^{-1} *cm^{-1} for the pheophytin.

Antioxidant activity assay: Several methods have been developed to assay the antioxidant activity of food extracts. In this study it used the method of scavenging of the radical 2, 2-diphényl-1-picrylhydrazyl (DPPH) activity. The antiradical activity of the radical DPPH° was determined by the methodology of Milardovic *et al.*[14]. It consists of mixing 2.9 mL of the DPPH° solution (6.10^{-5}M) with 0.1 mL of the mango extract, the absorbance of the DPPH ° solution was measured at 515 nm after 30 min of incubation in the dark at ambient temperature. The Percentage of DPPH° radical scavenging activity was determined as follow:

$$DPPH\ (\%) = \frac{A_C - A_S}{A_C} \times 100$$

where, A_s is the absorbance of the DPPH° solution containing samples and A_c is the absorbance of the control solution without sample but with DPPH°. The IC_{50} was calculated as the concentration of extracts causing a 50% inhibition of DPPH° radical.

Statistical analysis: The descriptive analysis of the results is performed with the Microsoft Office Excel 2007 software to determine averages and standard deviations and results are presented as mean±SD.

RESULTS

Antioxidant contents

Flavonols: Results showed that flavonols have the highest content in comparison with other pigments quantified in mango pulp powder with a rate of 228.95 mg EQ/100 g (Fig. 3).

Carotenoïds: The mango pulp powder exhibited a total carotenoïds content of 3.4 mg EC/100 g DW as it is illustrated in Fig. 3.

Lycopene: As it can be noted in Fig. 3, the lycopene, red pigments showed an outstanding content of 56.20 mg/100 g DW.

Anthocyanins: The anthocyanin content of mango pulp powder is shown in Fig. 3, which was 12.83 mg EQ/100 g DW.

Chlorophyll: As expected and as it can be seen in Fig. 3, the chlorophyll content of mango pulp powder was low with a tenor of 0.37 mg EP/100 g DW.

DPPH radical-scavenging activity: The methanolic extract of the mango pulp powder showed a very important antiradical activity of 91.12±0.41% with an IC_{50} of 109.75 mg mL^{-1} (Table 1). This high percentage testifies a high capacity of the extract of mango pulp powder to reduce the radical DPPH° due to the presence of antioxidant substances in the extract.

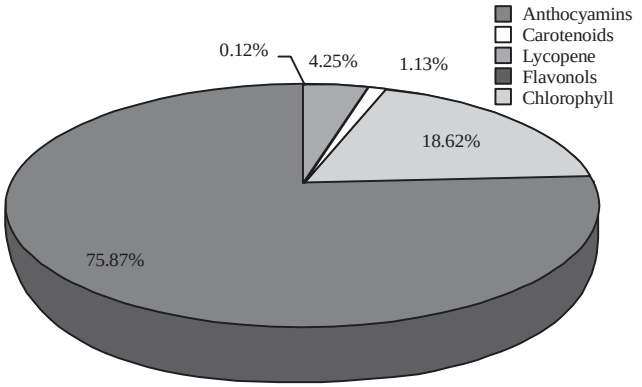

Fig. 4: Pigment distribution in mango powder

Table 1: Antiradical activity and IC_{50} of mango powder

Parameter	DPPH (%)	IC_{50} (mg mL^{-1})
Mango pulp powder	91.12±0.41	109.75

Distribution of the different pigments in the mango pulp powder: As it can be seen in Fig. 4, in terms of percentage, flavonols come in first class pigments brought by the mango pulp powder (75.87%), which partly explains the yellowish color of the mango pulp followed by lycopene (18.62%), anthocyanins (4.25%), carotenoïds (1.13%) and finally, the chlorophylliens pigments are virtually absent with a very low proportion of 0.12%.

DISCUSSION

In this study, pulp composition of mango fruit grown in Mali was evaluated for the contents of five pigments (flavonols, carotenoïds, lycopene, anthocyanins and chlorophyll) considering that all the components presented bioactivity related with antioxidant mechanism.

The rate obtained for flavonols was very low than those obtained by Tyug *et al.*[15], in their work on mango powder (bacang fruit from Malaysia) as they found 0.6±0.1 g EQ/100 g DW and higher than those recorded by Ribeiro *et al.*[16] in their study on some mangoes varieties as they found as total flavonols content in pulp, values ranging from 2.7-33.9 mg kg^{-1} of dry matter. These differences can be explained by the divergence of the methods used to drying mango and those followed for the extraction and quantification of antioxidants. In addition, the cultivars also showed some influence in terms of antioxidant activity and phenolic compounds content[17]. The total carotenoïd contents of mango (*Mangifera indica* L.) powders from Dong Thap province (Vietnam) reduced from 0.84-1.04 mg/100 g DW as the drying temperature increased[18] from 130-170°C and that of mango bacang (*Mangifera foetida*) from Malaysia was 107.2±8.5 µg β-carotene/100 g DW[15]. Zotarelli *et al.*[19] reported total carotenoïds value of mango pulp powder (Tommy Atkins) produced by spray dying was 113.2 µg g^{-1}, which is higher than the result of this study. The literature reported that the loss of β-carotene in mango puree processing is approximately[12] 13%. Divergences in the results can be interpreted be the fact that the drying temperature of the mango was not very important in this study (50°C), which had preserved carotenoïds content of the mango in comparison with the results of the other studies where drying temperatures were important. According to Sogi *et al.*[20], the drying methods utilizing heat had significant effect on carotenoïds degradation and they recorded the highest carotenoïds levels in the freeze dried samples. In general, carotenoïds are thermally labile, unstable at low water activity and susceptible to enzymatic degradation by lipoxygenase[21-23]. Thus, the authors also suggested that there has been a decrease in the carotenoïds rate due to the decrease in water content during drying. As for lycopene, a red carotenoïd, is the principal pigment of any red flesh fruits and vegetable. According to Shi *et al.*[24], the lycopene content in dehydrated tomato was affected by different dehydration methods, namely, heat treatment under atmospheric conditions, osmotic treatment and air-drying. The loss of lycopene was explained by isomerization and oxidation. However, the heat produced in the course of grinding is likely to affect the bioavailability of carotenoïds positively. The heat increases the dissociation of the protein-carotenoïd complex or causes dispersion of the carotenoïd crystals. To the best knowledge of authors, no results have been reported in the literature on the lycopene content in mango powder, although several studies evoke the richness of the fresh mango in lycopene[25]. The athocyanins content was 1.47±0.28 mg/100 g DW in the flesh of mango (*Mangefira pajang*) from Malaysia[26]. Anthocyanins content in mango peel was reported to be in the ranges of 203-565 mg cyanidin-3-glucoside equivalent in 100 g of sample depending on the variety[27]. In their work on some tropical fruits, Da Silva *et al.*[28] found an anthocyanin rate of 7.85±0.80 mg/100 g in mango pulp. However, the contents of total anthocyanins in the pulp samples were very low ranging from 0.0001-0.0005 mg/100 mL on some Chinese varieties[29]. Anthocyanin pigments are responsible for the attractive red to purple to blue colours of many fruits and vegetables. Anthocyanins are relatively unstable and often undergo degradative reactions during processing and storage[30]. Chlorophyll is a green pigment found in most plants, it is known that chlorophyll has positive effects on

inflammation, oxidation and wound healing. Results recorded in this study were similar to those reported by numerous researchers[31-33]. Indeed, during fruit ripening, green color pigment (chlorophyll) present in the fruit starts to degrade and synthesis of red and yellow color pigments like anthocyanins and carotenoïds takes place[34] in most of the fruits like bananas, mangoes and apples, etc. No evidence of reports about kinetics related to color change that occurs in mangoes during ripening.

There are several methods for the measurement of the antiradical activity of an extract, in this work the reduction of the free radical DPPH is used for the determination of this activity. In their study Ribeiro *et al.*[16] found that the pulp extracts from four mango varieties showed significantly different values of DPPH radical-scavenging activities ranging from 39.6-94.2%. The radical-scavenging activity is ranged between 73.90 and 85.95% in wines of some mangoes varieties from India[35]. Kuganesan *et al.*[36] found in their work on the mango pulp of the Karuthacolomban variety from Sri Lanka, an IC_{50}>500 μg mL^{-1} very low concentration than IC_{50} recorded in this study. Results from this study are far from those of Surinut *et al.*[37], as they classified the mango fruit among the fruits having high antioxidant activity with their IC_{50} from 1.10-9.60 mg mL^{-1}. This difference may be due to the drying methods applied and even varieties.

In this study distribution of the different pigments in the mango pulp powder concluded that flavonols come in first class pigments brought by the mango pulp powder (75.87%) as already stated, flavonols are the predominant pigments in mango pulp powder, which is important since flavonols are known for their potent antioxidant activity confirmed in several previous studies. Therefore, the mango pulp powder can be used as a functional ingredient[38-40].

The results of the present study showed that the mango powder has levels of some bioactive molecules comparable with other previous researches, the recorded fluctuations remain dependent on the variety itself and experimental techniques.

CONCLUSION

Mango has a short shelf life, thus drying or processing this fruit increased its availability. However, drying processing may cause loss or reduction of some nutrients and bioactive molecules due to the presence of oxygen, exposure to light or heat treatment. Despite this, the mango powder studied in this work has shown significant levels of antioxidant molecules including flavonols, carotenoïds and lycopene and even anthocyanins. Thus, application of drying for fresh mango to produce a pulp powder could help to create new products using the mango pulp powder as an ingredient (incorporation in yogurt, butter…etc) to get functional foods and thus reduce postharvest loss.

SIGNIFICANCE STATEMENT

Results from this study show the richness of mango powder in some bioactive molecules especially lycopene, which is not much sought in this fruit that can be beneficial for human health. This study will help the researcher to orientate their work on this molecule that previous work on mango did not deal with.

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