American Journal of Chemistry 2025, 15(3): 76-80
DOI: 10.5923/j.chemistry.20251503.03

Effects of Natural Convection Gas Drying on the Bioactive Compounds of Five Varieties of Mango Grown in Senegal

Mouhamadou Fofana[1,*], Ibrahima Ba[1], Ndiak Ndiaye[1], Bédié Mbow[1], Baye Dame Cissé[1], Alioune Fall[1], Nicolas Cyrille Ayessou[2]

[1]Department of Chemistry, Technologies and Sciences, University Cheikh Anta Diop of Dakar, Dakar, Senegal
[2]Department of Chemical Engineering and Applied Biology, Polytechnic School, University Cheikh Anta Diop of Dakar, Dakar, Senegal

Abstract The effects of natural convection gas drying on bioactive compounds were monitored in this study. The results reveal that the Sl, Bk, and Knt mango varieties have the lowest moisture content, at 11.27%, 11.31%, and 11.43%, respectively. In contrast, Kt and Dr have the highest moisture content, at 12.07% and 12.48%. This difference in moisture content between these varieties can be explained by the fact that some contain more water than others. The drying process causes a significant decrease in total polyphenol and flavonoid levels in all varieties, due to the degradation of heat- and light-sensitive compounds. Notably, the Bk variety stands out for its total polyphenol content before drying, while Kt and Bk show the highest levels after treatment. Fresh varieties retain higher levels of flavonoids than dried varieties, with Dr and Sl showing the highest levels, respectively 8mg EqAG/100g and 7mg EqAG/100g among local varieties. After drying, the antioxidant capacity of all varieties increases significantly, partly due to the concentration of antioxidant compounds. For fresh mangoes, the Dr, Sl, and Knt varieties have twice the antioxidant capacity of Kt, while after drying, Bk and Sl have the highest values, reaching 83%.

Keywords Bioactive compounds, Mango varieties, Fresh and dried

1. Introduction

Senegal is undeniably a major player in mango production, boasting a remarkable diversity of cultivated varieties. Among these, the Kent variety stands out for its high export volume, followed by Keitt, which is highly appreciated by consumers. However, a persistent challenge remains: the significant loss of local varieties, often caused by rotting [1]. To address this issue, the processing of mangoes into by-products has been implemented in recent years, with drying being the preferred preservation method [2]. This process offers a promising solution for limiting post-harvest losses. Processing is mainly carried out in artisanal units, often managed by women's groups, as well as in semi-industrial facilities, although industrial units remain rare [3]. This study aims to explore the effects of drying on the bioactive compounds of five mango varieties grown in Senegal. It is important to note that foods subjected to prolonged heat can lose their organoleptic qualities and valuable bioactive compounds [4]. By analyzing the variation in biochemical composition during drying, we will be able to identify the varieties best suited to this process. Based on previous work [5], it should be noted that this study focuses on the most widely grown and prized mango varieties in Senegal. Among these, two varieties, Kent (Knt) and Keitt (Kt), are mainly intended for export, while the other three, Diourrou (Dr), Boukodiékhal (Bk), and Sierra Leone (Sl), are more geared toward local consumption and domestic marketing [5].

* Corresponding author:
fofpc@yahoo.fr (Mouhamadou Fofana)
Received: Jul. 22, 2025; Accepted: Aug. 10, 2025; Published: Aug. 13, 2025
Published online at http://journal.sapub.org/chemistry

2. Methods and Materials

2.1. Materials

Figure 1. Mango samples

The mango samples were harvested from an orchard located in the village of Kaguitte, in the Ziguinchor region, Oussouye department. For this purpose, we collected fifteen kilograms of each variety, commercially ripe and without damage. The mangoes were stored at the drying center until they reached the desired level of ripeness.

2.2. Drying Equipment

The technology used is a natural convection gas dryer equipped with forty-two racks. The external dimensions are as follows: length: 6.96 m, width: 2.438 m, height: 2.591 m. Equipment accompanying the dryer includes: a scale, plastic basins, peeling knives, gloves, face masks, and smocks. The drying time is twelve hours.

Figure 2. Drying shed in Kandialan Diola (in the municipality of Ziguinchor)

3. Method

3.1. The Drying Stages

The mangoes are sorted, washed with drinking water, drained, and weighed. After peeling and pitting, they are cut into slices. The skins, pits, and pulp are also weighed. The slices are then laid out on racks, making sure to leave space between them for drying. Finally, the slices are packaged in bags using a vacuum sealer

Figure 3. Mango slices being processed, mango slices on the rack, and bags of dried mangoes

3.2. Measurement of Total Polyphenols, Flavonoids, Antioxidant Activity and Determination of Moisture Content

➢ Measurement of total polyphenols:

For polyphenols, the Folin-Ciocalteu method is used, which involves oxidizing the oxidizable groups of phenols in a basic medium. The blue-colored reduction products have an absorption intensity proportional to the amount of polyphenols present. The absorbances are read at 760 nm. The total polyphenol concentration is given by the relationship:

$$C_P = \frac{(A-b)}{a} * Fd * \frac{v}{1000} * \frac{100}{m}$$

CP: Total polyphenol content expressed in g gallic acid equivalent/100 g;

A: Actual absorbance of the sample;

a: Slope of the calibration curve = 3.12;

b: Y-intercept of the calibration curve = 0.0696;

Fd: Dilution factor;

v: Extraction volume (mL);

m: Test sample (g).

➢ Flavonoid dosage:

The flavonoid content of the extracts is determined using the colorimetric method described by (6). The results are expressed in g catechin equivalent per 100 g of product.

$$C = \frac{A * Pm}{\varepsilon} * fd * \frac{v}{1000} * \frac{100}{m}$$

C: Total flavonoid content expressed in g catechin equivalent/100 g;

A: Absorbance of the sample;

Pm: Molar mass of catechin = 290.26 g/mol;

ε: Molar extinction coefficient = 10,332 L/mol;

Fd: Dilution factor;

v: Extraction volume (mL);

m: Test sample (g).

➢ Antioxidant activity:

It was evaluated with 2,2-diphenyl-1-picrylhydrazyl ($DPPH^{\cdot}$) according to the method described in [6]. In addition, some adjustments were made to this protocol. That HAT mechanism is reported and followed by phenolic antioxidants. The antiradical activity is expressed as a percentage of reduced $DPPH^{\cdot}$ according to the equation...

$$AAR\ (\%) = \frac{Control_{\ Absorbance} - Sample_{\ Absorbance}}{Sample_{\ Absorbance}}$$

Also, the concentration reducing 50% of $DPPH^{\cdot}$ (IC50) is determined graphically on the antiradical activity (ARA) curve as a function of pulp concentration.

➢ Determination of moisture content.

A quantity of 2g of samples is placed in a pre-dried and tapped capsule. The sample is then placed in an oven maintained at a temperature of 130 ℃ for 90 minutes. After the drying period, the capsule is immediately removed and transferred to a desiccator to cool. Once cooled, the sample is weighed accurately. The moisture content is expressed as a percentage and is given by the following equation:

$$\%\ \text{Humidity} = \frac{\text{m1} - \text{m2}}{\text{m1} - \text{m0}}$$

m_0 = the mass in g of the test capsule (sample).

m_1 = the mass in g of the test sample + the mass of the capsule before drying.

m_2 = the mass in g of the test sample + the mass of the capsule after drying.

3.3. Text Font of Entire Document

The entire document should be in Times New Roman. The font sizes to be used are specified in Table 1.

The size of a lower-case “j” will give the point size by measuring the distance from the top of an ascender to the bottom of a descender.

4. Results and Discussions

4.1. Water Content of Dried Mangoes

Table 1 shows the results for the relative humidity of our dried mango samples.

Table 1. Relative humidity

Varieties of dried mangoes	Humidity (%)
Knt	11.43±0.12
Bk	11.31±0.15
Dr	12.48±0.21
Sl	11.27±0.16
Kt	12.07±0.22

The results in Table 1 show that the Sl, Bk, and Knt varieties have the lowest moisture content, at 11.27%, 11.31%, and 11.43%, respectively. In contrast, the Kt and Dr varieties have the highest moisture content, at 12.07% and 12.48%, respectively. This difference in moisture content between these varieties can be explained by the fact that some contain more water than others. These values are better than those reported by [7] (approximately 15%) and lower than those obtained by oven drying according to [8].

4.2. Total Polyphenol Content of Fresh and Dried Mango Varieties

Figure 4 illustrates the total polyphenol content of different mango varieties, both fresh and after drying.

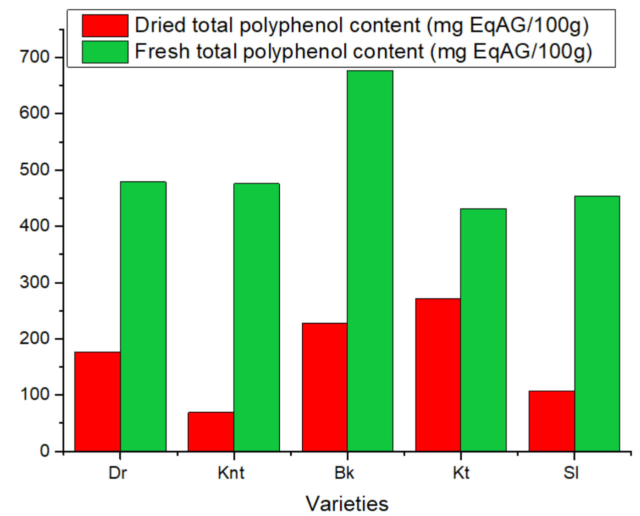

Figure 4. Total polyphenol content of fresh and dried mango varieties

The results presented in this graph show that the total polyphenol content decreases significantly after drying for all varieties. Drying can cause degradation of certain heat- and light-sensitive antioxidant compounds, such as vitamin C and certain polyphenols.

During the drying of fruits and other materials, the degradation of bioactive compounds is based on the basic reactions described below, and the rate of degradation is mainly influenced by temperature, oxygen content, and humidity [4]:

$$2\,RCH_2{-}OH + O_2 \longrightarrow RCHO + 2H_2O \text{ (Dehydrogenation)}$$

$$2RCHO + O_2 \longrightarrow 2\,RCOOH \text{ (Oxygenation)}$$

Dehydrogenation reaction of hydroxyl group (–OH) to form ketone group (C=O), as,

$$4R{-}OH + O_2 \longrightarrow 2RCOR + 2H_2O \text{ (Dehydrogenation)}$$

Oxygenation of hydroxyl group (–OH) to carboxyl group (–COOH):

$$2R{-}OH + O_2 \longrightarrow 2\,RCOOH \text{ (Oxygenation)}$$

Figure 5. Formation of theaflavins from catechins by dehydrogenation

Here are the typical degradation reactions of phenols (catechins) [4]:

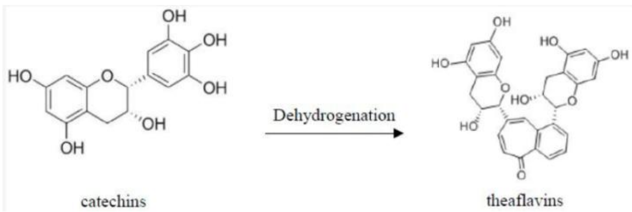

Figure 6. Formation of theaflavins from catechins by dehydrogenation

The Bk variety has the highest total polyphenol content before drying, compared to the four other varieties, which have similar values. After drying, the Kt and Bk varieties have the highest contents, respectively. The total polyphenol content of these two dried varieties (Kt and Bk) is higher than those studied by [9]. The local variety Bk is an interesting variety from a polyphenolic point of view.

4.3. Flavonoid Content of Fresh and Dried Mango Varieties

Flavonoids act primarily as primary antioxidants, stabilizing peroxide radicals, but they can also deactivate reactive oxygen species (superoxide ion, OH- radical, singlet oxygen), inhibit lipoxygenase, or chelate metals [2].

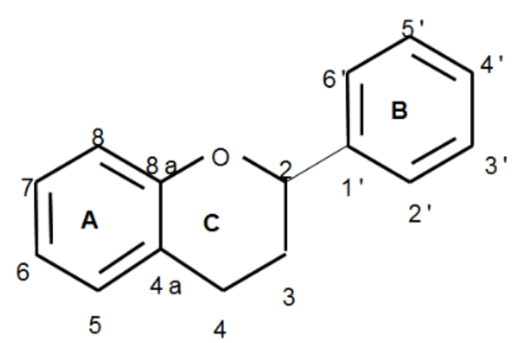

Figure 7. Generic structure of flavonoids

Figure 8 shows the flavonoid content of mango varieties, both fresh and dried.

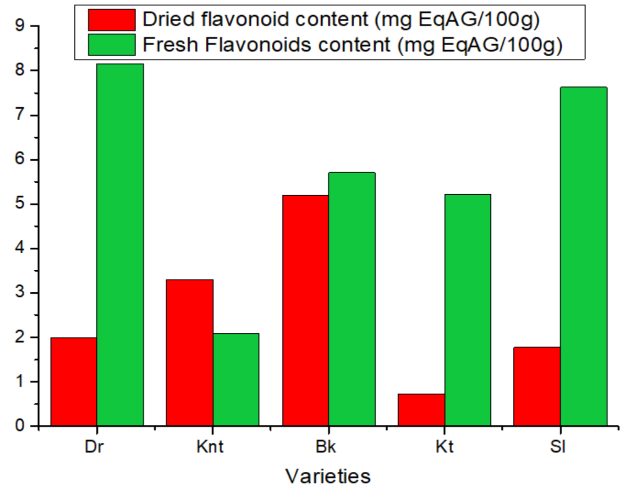

Figure 8. Flavonoid content of fresh and dried mango varieties

As we have seen with polyphenol content, fresh varieties always contain higher levels of flavonoids than dried varieties. When baicalein is oxidized into corresponding ketone compounds, the original yellow color turns green and the effectiveness of the bioactive ingredients is degraded.

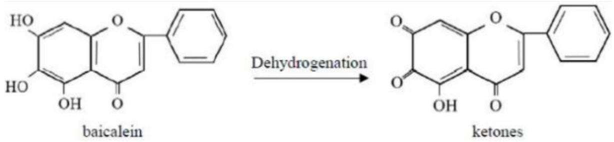

Figure 9. Chemical structure of baicalein and its oxidation products

The local varieties Dr and Sl stand out from the improved varieties, with high flavonoid contents of 8 mg EqAG/100 g and 7 mg EqAG/100 g, respectively. The Knt variety, on the other hand, is lower in flavonoids, with 2 mg EqAG/100 g. The varieties studied by [9] contain higher flavonoid levels than our varieties. After processing (drying), the flavonoid content decreases considerably for most varieties. However, it should be noted that the Bk and Knt varieties retain the highest levels. A striking fact is that the fresh Knt variety had the lowest flavonoid content.

4.4. Antioxidant Capacity of Fresh and Dried Mango Varieties

Antioxidants are generally referred to as “free radical fighters” because they generously give up electrons to free radicals without turning into electron-trapping substances. Free radicals are therefore also more susceptible to oxidation [10].

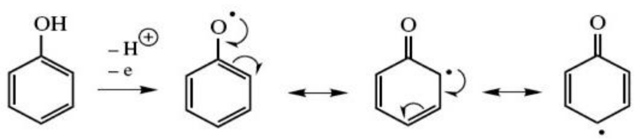

Figure 10. Single-electron oxidation of a phenol

The figure below shows the antioxidant power of mango varieties, both fresh and dried.

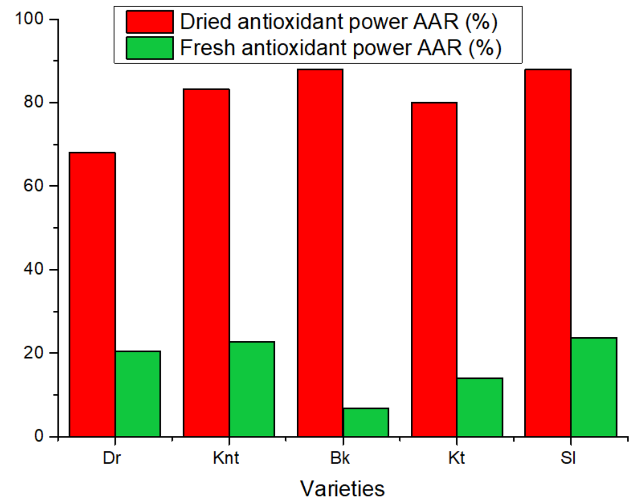

Figure 11. Antioxidant power of fresh and dried varieties

The data shown in Figure 8 indicates that after drying, the antioxidant capacity of all varieties increases significantly, consistent with the results of 4. By removing water, the remaining antioxidant compounds can become more concentrated, which may increase the overall antioxidant capacity of the dried food [11]. The high antioxidant activity in fruits and vegetables after drying may be due to the fact that partially oxidized polyphenols have higher antioxidant activity than unoxidized polyphenols. In addition, Maillard reaction products, which can form as a result of heat treatment or prolonged storage and generally have strong antioxidant properties, may be linked to increased antioxidant capacity after drying [11]. Regarding fresh mangoes, the three varieties (Dr, Sl, and Knt) have an antioxidant capacity of 20%, which is twice as high as that of the Kt variety. After drying, the Bk and Sl varieties stand out with the highest values, reaching 83%.

5. Conclusions

This study highlights significant differences in moisture content, polyphenol, and flavonoid levels among various mango varieties, both fresh and after drying. The Sl, Bk, and Knt varieties have the lowest moisture content, while Kt and Dr have higher levels, which directly impacts their storage potential. Although drying is effective in reducing moisture and concentrating certain compounds, it causes significant degradation of polyphenols and flavonoids, thereby affecting the bioactive properties of the fruit. The results also highlight the importance of variety in preserving antioxidant compounds, with Bk standing out for its high polyphenol content before drying, and Kt and Bk retaining significant levels after processing. Despite a general decline in flavonoids after drying, certain varieties, such as Bk, retain relatively high levels. Finally, the increase in antioxidant power after drying is a positive aspect of processing, suggesting that the remaining compounds may offer increased nutritional benefits. This research opens up promising prospects for the promotion of mangoes, both for local consumption and for export, with an emphasis on the varieties best suited to processing.

REFERENCES

[1] BA Ibrahima et al. Ijsrm.Human, 2020; Vol. 15 (1): 45-57. The Mango Sector in Senegal Cultivation Systems and Techniques and Constraints

[2] Ba, I.; Fofana, M.; Diouf, E.; Mbow, B.; Ayessou, N.; Faye, F. Effects of the Drying Technique Used on the Contents of Total Polyphenols, Flavonoids and Antioxidant Activity of Five Varieties of Mangoes (Mangifera Indica) Dried in Senegal. AB 2024, 12 (2), 49–59. https://doi.org/10.11648/j.ab.20241202.12.

[3] Conception_et_Realisation_dun_Sechoir_Solaire_Ind., A. Boulemtafes et al.; Valorisation (1999) 97-100

[4] Sharma, K.; Bari, S. S.; Singh, H. P. Biotransformation of Tea Catechins into Theaflavins with Immobilized Polyphenol Oxidase. Journal of Molecular Catalysis B: Enzymatic 2009, 56 (4), 253–258. https://doi.org/10.1016/j.molcatb.2008.05.016.

[5] Maldonado-Celis, M. E.; Yahia, E. M.; Bedoya, R.; Landázuri, P.; Loango, N.; Aguillón, J.; Restrepo, B.; Guerrero Ospina, J. C. Chemical Composition of Mango (Mangifera Indica L.) Fruit: Nutritional and Phytochemical Compounds. Front. Plant Sci. 2019, 10. https://doi.org/10.3389/fpls.2019.01073.

[6] Physiochemical Properties and Antioxidant Potential of Persea Americana Seed Oil. Chemistry International 2022, 168–175.

[7] Kameni, A.; Mbofung, C. M.; Ngnamtam, Z.; Doassem, J.; Hamadou, L. Aptitude au séchage des fruits de quelques variétés de manguiers cultivées au Cameroun. Fruits 2003, 58 (2), 89–98. https://doi.org/10.1051/fruits:2002039.

[8] Mwamba, I.; Tshimenga, K.; Mbabu, D.; Conas, M.; Kanyinda, J.-N. M. Séchage des mangues par étuvage et au soleil.

[9] Akther, S.; Jothi, J. S.; Badsha, Md. R.; Rahman, Md. M.; Das, G. B.; Alim, Md. A. Drying Methods Effect on Bioactive Compounds, Phenolic Profile, and Antioxidant Capacity of Mango Powder. Journal of King Saud University - Science 2023, 35 (1), 102370. https://doi.org/10.1016/j.jksus.2022.102370.

[10] Velioglu, Y. S.; Mazza, G.; Gao, L.; Oomah, B. D. Antioxidant Activity and Total Phenolics in Selected Fruits, Vegetables, and Grain Products. J. Agric. Food Chem. 1998, 46 (10), 4113–4117. https://doi.org/10.1021/jf9801973.

[11] ElGamal, R.; Song, C.; Rayan, A. M.; Liu, C.; Al-Rejaie, S.; ElMasry, G. Thermal Degradation of Bioactive Compounds during Drying Process of Horticultural and Agronomic Products: A Comprehensive Overview. Agronomy 2023, 13 (6), 1580. https://doi.org/10.3390/agronomy13061580.