World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(RESEARCH ARTICLE)

Check for updates

Evaluation of the physical properties of fresh and dried peppercorns grown in Côte d'Ivoire

Moussa Coulibaly [1,*], Antoinette Béhibolo Yoboue [2], Doudjo Soro [1] and Emmanuel Nogbou Assidjo [1]

[1] *Department of Nutrition and food Technology Group (GNTA), Laboratory of Industrial Processes of Synthesis and environment (LAPISEN) Felix Houphouët-Boigny National Polytechnic Institute, Yamoussoukro, Côte d'Ivoire.*
[2] *Laboratory of Medical Biochemistry, Unit of Training and Medical Research, Alassane Ouattara University (UAO), Bouaké, Côte d'Ivoire.*

World Journal of Advanced Research and Reviews, 2023, 19(02), 204–210

Publication history: Received on 19 June 2023; revised on 27 July 2023; accepted on 29 July 2023

Article DOI: https://doi.org/10.30574/wjarr.2023.19.2.1534

Abstract

The pepper plant (*piper nigrum*) is mainly grown for its fruit. Indeed, its fruits are mainly used as spices and condiments. The objective of this study was to determine the physical properties of fresh and dried pepper domesticated in Côte d'Ivoire. Physical parameters such as density, diameter and color of fresh and dried pepper seeds were analyzed. Samples of fresh and dried pepper were collected in the various production localities selected on the basis of pedological data. In addition, sampling was carried out over two (2) years. The results obtained indicate a high density of fresh and dried pepper in samples taken in the localities of Niablé (1004 kg/m3) and PK 103 (1006.4 kg/m3). The largest diameters of fresh and dried pepper were observed in the Assouba (5.4 mm) and N'douci (5.1 mm) samples. The highest luminance values for fresh and dried pepper were obtained in the Guibéroua (14.67) and Danane (22.01) samples. The highest chromatid a* values for fresh and dried pepper were obtained in samples from Assouba (3.69) and Guibéroua (4.06), and the highest chromatid b* values for fresh and dried pepper were recorded in samples from Guibéroua (6.85) and Danane (4.97).

Finally, the results obtained highlight the importance of physical parameters such as density, diameter and color in the marketing of fresh and dried pepper.

Keywords: *Piper Nigrum*; Physical properties; Diameter; Density; Color

1. Introduction

A spice is an organic material of plant origin that generally has a powerful flavor. As such, they are used to season dishes and enhance their taste. They can be derived from bark (cinnamon), leaves (tea, laurel), bulbs (garlic, onion, ginger), seeds (fennel, coriander) or fruit (mustard and pepper). Pepper (Piper nigrum L.) is one of the best-known and most widely used spices. It originates from the Malabar region of southern India. It is grown mainly in India, Malaysia, Brazil, Indonesia and Sri Lanka. World pepper production has declined considerably in recent years. It has fallen from 633,000 tonnes in 2019 to 497,000 tonnes in 2021. Then, demand for pepper was estimated at around 505,000 tonnes, but total available production was 497,000 tonnes, i.e. a deficit of 8,000 tonnes, which represents a real shortfall for producers in 2021. Production in Africa was estimated at 22,342 tonnes. In Côte d'Ivoire, the quantity of pepper harvested was estimated at 57.46 and 45.03 tonnes in 2020 and 2021 respectively [1]. Depending on the degree of purity and the processing method, different types of pepper can be obtained. Firstly, green pepper is obtained after harvesting ripe berries. Next, black pepper is produced from mature but still green berries that are sun-dried, while white peppers are mature berries that are first skinned and then sun-dried. Thus, pepper's popularity is due to its flavor and pungency [2].

* Corresponding author: Moussa Coulibaly

Various physical properties of pepper seeds depend on moisture content and appear to be important in seed preservation and processing. Despite an extensive literature search, very little information on the physical properties of fresh and dried pepper seeds is available in the literature. Most spices are highly hygroscopic foodstuffs, interacting easily with air humidity. The risk of mold growth is naturally highest in warm, humid air. Pepper seeds must be uniform in color, uniform in size and free from blemishes. Quality degradation occurs in particular with excessively moist and excessively hot product, and can be recognized by discoloration of the seed [3].

In this study, the physical properties such as density, diameter and color of fresh and dried peppercorns from Côte d'Ivoire were determined with a view to marketing them on the national and international markets.

2. Materials and methods

2.1. Plant material

The plant material for this study consisted of fresh and dried pepper. The various samples were collected in areas of high pepper production (Figure 1).

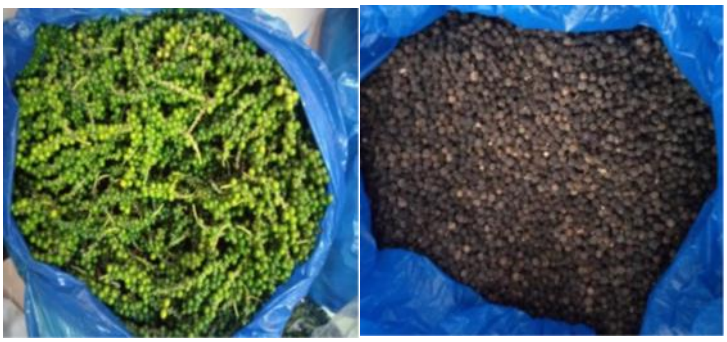

Figure 1 Fresh pepper with grapes and dried pepper without grapes

2.2. Methods

2.2.1. Choice of sampling sites

An analysis of the database of the Association des producteurs de poivre de côte d'ivoire shows that there are currently 38 plantations in production in côte d'ivoire. Given the geographical composition and soil distribution of Côte d'Ivoire, these plantations can be grouped into 10 different entities. These plantations are mainly located in Azaguié, Maféré, N'douci, Guibéroua, Danané, Niablé, Yakassemé, Lopou, Assouba and Pk 103.

2.2.2. Sampling

Fresh and dried pepper samples were taken in ten (10) localities. Sampling was carried out over two (2) years, with one sample taken in each of the ten (10) localities during the production season (March to April). In each locality, three (3) 1.5 kg samples of fresh pepper and three (3) 1.5 kg samples of dried pepper were taken in the first year. Then, two (2) samples of 1.5 kg fresh peppers and two (2) samples of 1.5 kg dried peppers were taken in the second year. Finally, the samples were taken from the bags and stored in a cool box (fresh pepper) before being transported to the laboratory for analysis.

2.2.3. Density determination

Density was determined according to the method described by Pomeranz and Meloan [4]. Ten (10) grams of fresh and dried pepper samples were weighed using a precision balance. The samples were then transferred to a graduated cylinder containing 80 mL of distilled water. The density was then obtained by dividing the density of the peppercorns by the density of the water used as a reference body.

2.2.4. Diameter determination

Diameters were determined using a caliper (FACOM, France) with an accuracy of ± 0.01 mm, which was used to measure the dimensions (major, middle and minor axes) of 10 randomly selected grains in each sample. The average of the determinations was recorded as the data obtained [5].

2.2.5. Color determination

Color measurements were carried out on whole peppercorns using a colorimeter (Konica Minolta, Model CR-400, Japan). Color was expressed in mean values L*, a*, b*, from the International Lighting Commission where the L* value represents the degree of clarity defined from black to white (0-100), a* represents the shade between green and red and the b* value represents the spectrum evolving from blue to yellow. The instrument was normalized using the white porcelain standard (L = 93.24, a = 0.96, b = 2.75) [5].

2.3. Statistical analysis

The numerical data obtained were entered using Excel version 2016 and processed using STATISTICA 7.1 software. Statistical differences in means were tested by analysis of variance (ANOVA). The significance of differences between samples was determined using Duncan's test. The significance level was $p < 0.05$.

3. Results

3.1. Black pepper kernel density

The densities of the black pepper samples collected at the various selected sites are shown in figure 2. The density was highest for the Niablé sample (1.008 ± 0.001 kg/m3) and Pk 103 (1006.4 kg/m3), while the dried pepper samples from Assouba had a lower density (1002.2 ± 0.001 kg/m3). Fresh peppercorns from Yakassemé had a density of 1002.2 ± 0.001 kg/m3.

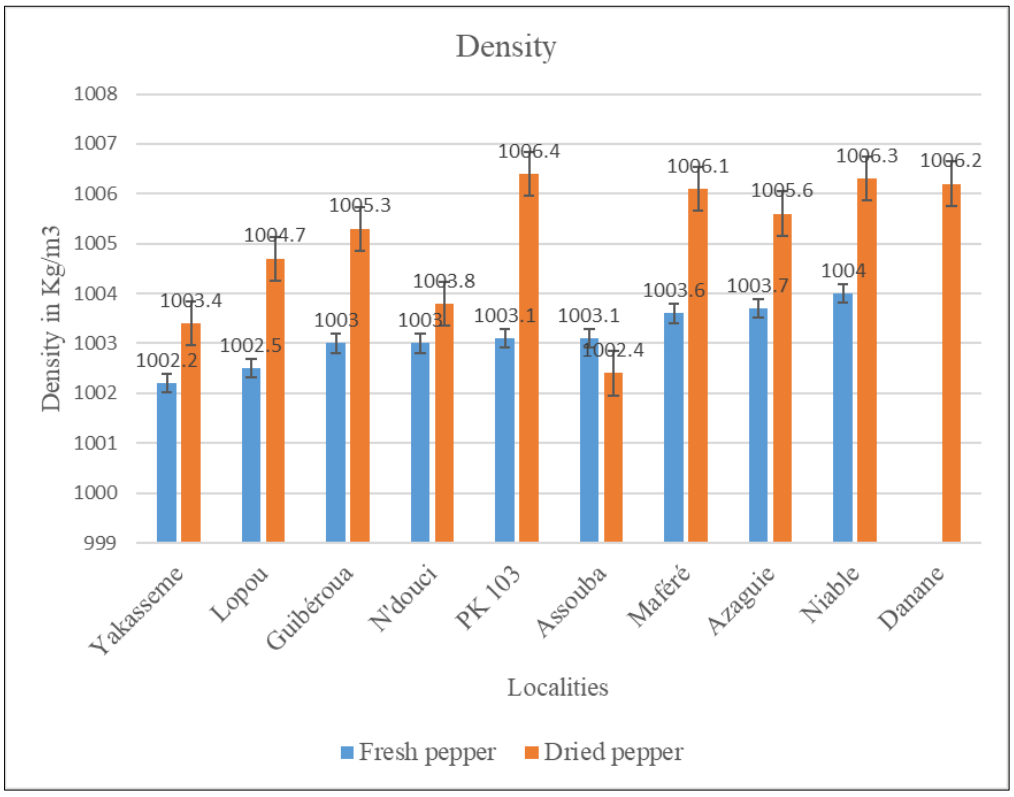

Figure 2 Density of fresh and dried pepper samples

3.2. Diameter of fresh and dried peppercorns

The fresh and dried pepper samples observed at the ten (10) study sites all showed whole berries, visibly well rounded or oval in shape with crumpled pericarp over a diameter range from 4.2 ± 0.00 mm to 5.4 ± 0.03 mm (Figure 3). Fresh pepper samples from Assouba (5.4 mm) and Yakassemé (5.2 mm) recorded the largest berries, followed by berries from Yakassemé (5.00 ± 0.00 mm) and N'douci (5.1 ± 0.03 mm). In contrast, the Niablé sample (4.3 and 4.2 mm) had the smallest fresh and dried peppercorns.

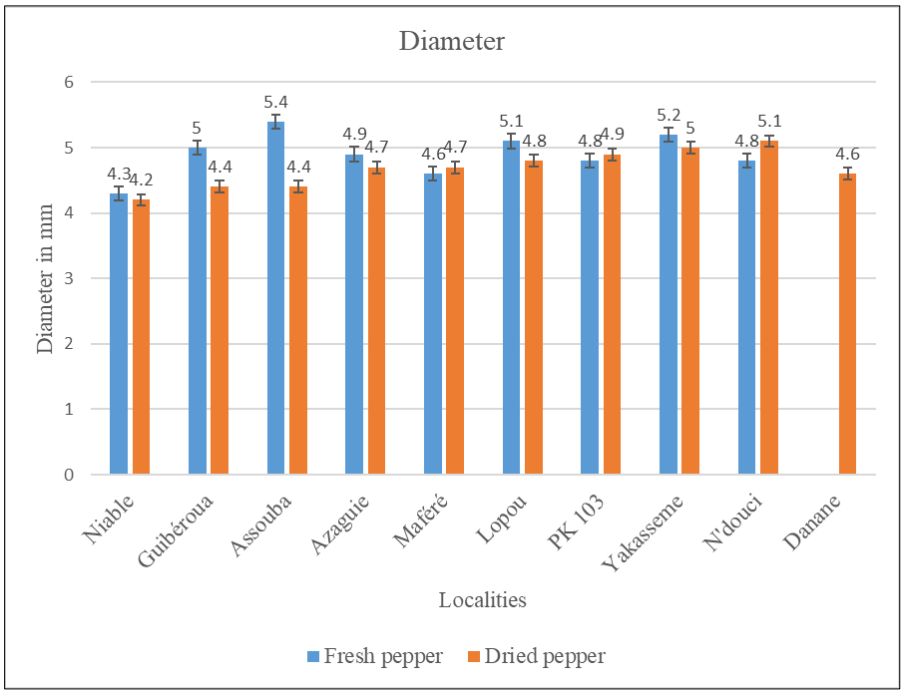

Figure 3 Diameter of fresh and dried peppercorns

3.3. Color of fresh and dried pepper

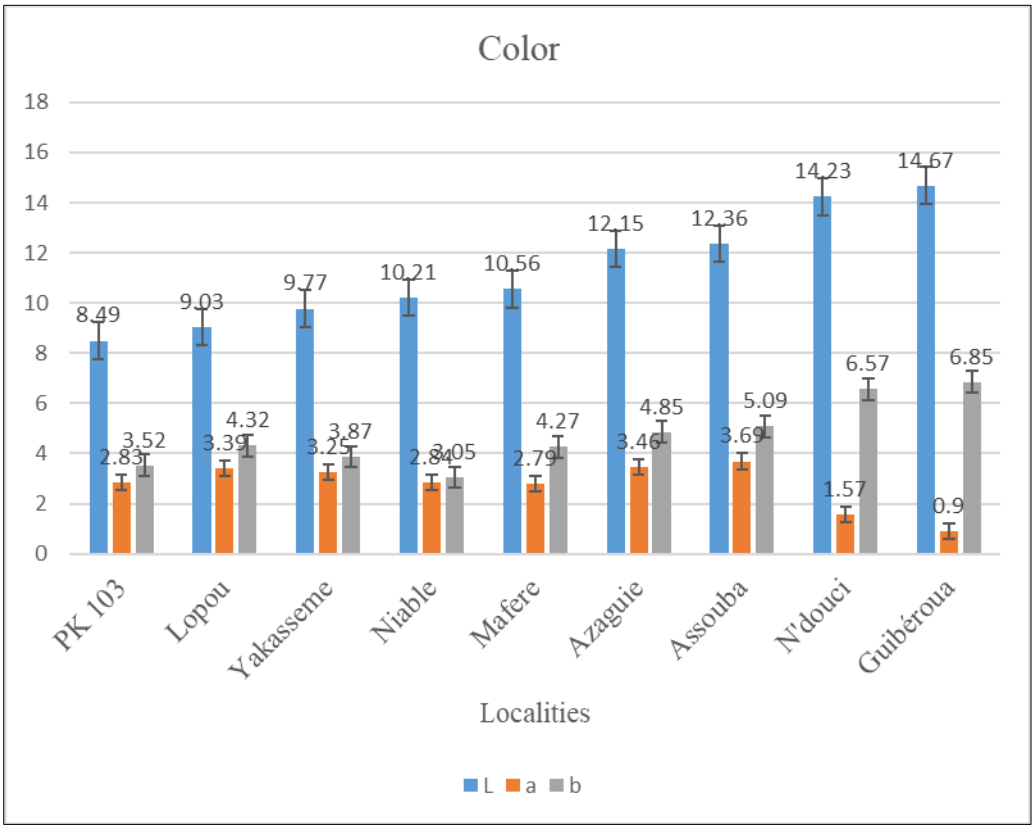

Figure 4 Color of fresh pepper from Côte d'Ivoire

Figure 4 and 5 shows the statistical results for color parameters. All fresh and dried pepper samples show a lightness "L*" closer to black (0) than to white (100), with the highest intensity (14.67 and 22.1) recorded in fresh pepper samples collected in Guibéroua and Danané respectively. Next, the lowest intensity was observed in fresh and dried pepper samples collected in PK 103 (8.49) and Guibéroua (11.96) respectively. On the other hand, samples of fresh and dried pepper collected in Guibéroua and Assouba showed both the lowest intensities of the Yellow - Red spectrum evaluated at 0.9 and 4.06 respectively, while the highest values were observed in samples collected in Assouba (3.69) and Guibéroua (4.06) respectively of fresh and dried pepper.

The lowest intensities of the Blue-Green spectra were obtained in the fresh and dried pepper samples taken from Niablé (3.05) and Yakasseme (6.85) respectively, while those from Danane (4.97) and Guiberoua (6.85) showed higher values. Secondly, fresh peppers have lower chromatic values.

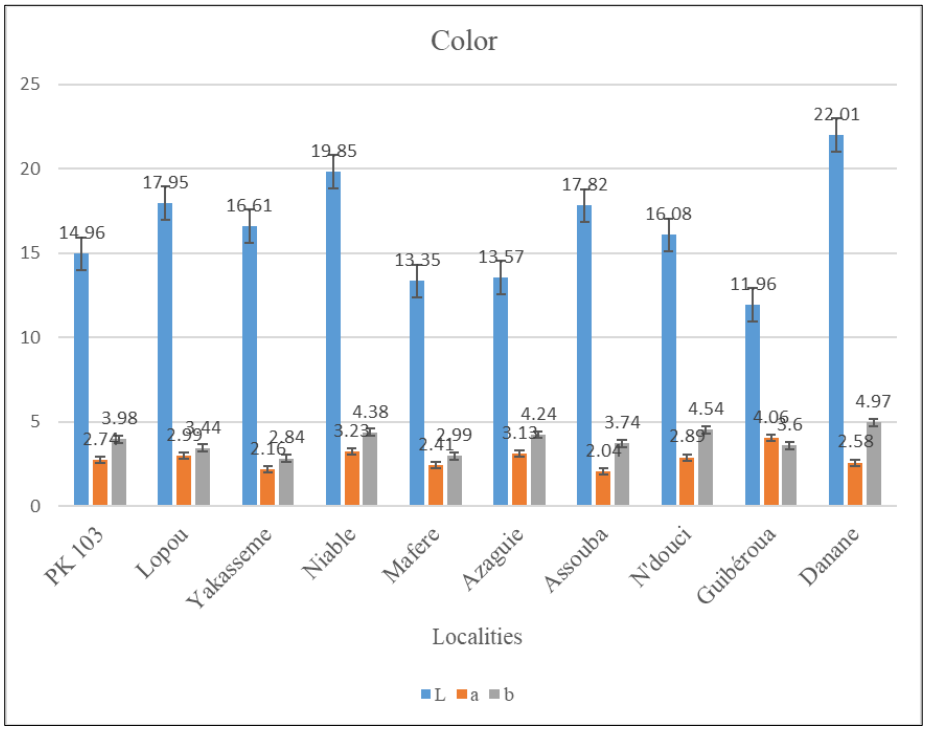

Figure 5 Color of dried pepper from Côte d'Ivoire

4. Discussion

The results showed that berry density in all localities was relatively high. With values above for all fresh and dried pepper samples studied. This could mean that the fresh and dried pepper samples analyzed would contain a negligible amount of light berries, which are dry, hollow, cellulose-rich grains of low density [6]. The fresh pepper samples collected in the PK 103 locality, which recorded the densest berries (1006.4 kg/m3), could be the one containing the least. Moreover, the results obtained in the present study are well corroborated by those of Balasubramanian et al [7], according to whom the intrinsic density of peppercorns varies between 987 and 1012 kg/m3. However, this slight variation observed between the densities of the samples could be explained by the heterogeneity in percentage of mass and size moisture that exists between peppercorns from one locality to another [8, 9].

In terms of kernel size, all samples showed a diameter range from 4.00 mm to 5.20 mm, which corresponds to the normative values of the diameter parameter set by CODEX [10] ranging from (2.5mm to 7.0mm). The slightly oval but essentially round shapes of the Ivory Coast black pepper samples correspond to those described by Meilawati et al [11] at five observation sites in Indonesia. It should be noted that size is an important parameter, as peppercorns of larger diameter contain more aromatic compounds, making the taste of Tellicherry black pepper (a town in southern India) more complex and not just "peppery" [12]. In fact, almost 50% of the samples studied, made up of black peppers from Lopou (4.80 ± 0.03mm), Yakassemé, Azaguié (5.00 ± 0.00 mm), Pk 103 and N'douci (5.20 ± 0.03mm) had a diameter similar to the prestigious pepper (4.8 mm) from India [13].

Secondly, fresh peppers have lower chromatic values. Color is an important criterion in food valuation. It represents consumers' first impression. Lycopene is responsible for the red color of overripe peppers like tomatoes. The L* (lightness measurement) values found were closer to 0 than 100, reflecting the overall black, dark brown color of the dried peppercorns studied, as recommended by the International Pepper Community (IPC) [14] and the European Spice Association (ESA) [15]. This blackening consists in the enzymatic oxidation of polyphenolic compounds by phenolases (polyphenoloxidases and peroxidases) into highly reactive quinones, which then polymerize to form brown compounds [5]. The intensity of blackness in the peppercorns studied was strongly influenced by the bleaching and drying quality used from one locality to another [16, 17]. In fact, moderate bleaching promotes uniform blackening by encouraging phenol oxidation by phenolase, whereas more intense bleaching deactivates the enzymes involved, thereby limiting pepper browning [18]. We therefore understand that the bleaching applied may, depending on the case, have favored the enzymatic browning reaction, resulting in darker grains (of less intense clarity) such as those from Maféré (13.07 ± 0.86), Guiberoua (13.19 ± 1.53) and Azaguié (13.92 ± 2.61). However, grains with higher clarity, such as those from Niablé (19.92 ± 1.62) and Danané (23.62 ± 1.39), are comparable to those reported by Song et al. [19], who found a value of (22.26 ± 0.40). Drying, the other thermal operation in the black pepper production chain [20] and known to have an impact on pepper color, would be the cause of these chromatic values obtained from a* (yellowing) and b* (reddening) as observed by Weil et al. [5] for Piper borbonense.

5. Conclusion

The study of the physical parameters of fresh and dried pepper is very important for assessing pepper quality. Pepper has very interesting diameters, as the grains are round and oval on the whole. Secondly, pepper diameters comply with the various standards set by the Codex Alimentarius. The peppers analyzed have negligible quantities of light berries. Color and density are important criteria in the valuation of peppers and a first impression for consumers. Clarity reflects the overall black and dark brown color of the peppercorns. It rises sharply from 8.49 to 22.01. Peppers from PK 103 (8.49) had low clarity, while samples from Danane (22.01) had high clarity. Pepper samples from Guiberoua (0.9) were less yellow than those from Assouba (3.69). In addition, samples collected in PK 103 (2.84) had less reddish peppers, whereas samples from Guiberoua (6.85) had redder peppers.

Compliance with ethical standards

Acknowledgments

The authors thank Interprofessional Fund for Agricultural Research and Advice (FIRCA) for project funding.

Disclosure of conflict of interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] FAOSTAT, « Pepper (Piper nigrum) production. Italy: FAO Statistics Division, Food, and Agriculture Organization. », 2023, Consulté le: 16 juin 2023. [En ligne]. Disponible sur : URL : http://www.fao.org/faostat/en/#compare

[2] H. H. Jeleń et A. Gracka, « Analysis of black pepper volatiles by solid phase microextraction–gas chromatography: A comparison of terpenes profiles with hydrodistillation », J. Chromatogr. A, vol. 1418, p. 200-209, oct. 2015, doi: 10.1016/j.chroma.2015.09.065.

[3] Y. Coşkuner et E. Karababa, « Physical properties of coriander seeds (Coriandrum sativum L.) », J. Food Eng., vol. 80, no 2, p. 408-416, mai 2007, doi: 10.1016/j.jfoodeng.2006.02.042.

[4] Y. Pomeranz et C. E. Meloan, « High-Performance Liquid Chromatography and Ion Chromatography », in Food Analysis, Boston, MA : Springer US, 1994, p. 324-351. doi: 10.1007/978-1-4615-6998-5_21.

[5] Weil Mathieu, « Étude des procédés de transformation de poivres sauvages d'îles de l'océan indien : impact sur la qualité (piquant, arôme et couleur) », Université de Montpellier Supagro, 2018.

[6] A. Massaro et al., « Non-targeted authentication of black pepper using a local web platform : Development, validation and post-analytical challenges of a combined NIR spectroscopy and LASSO method », Food Control, vol. 145, p. 109477, mars 2023, doi: 10.1016/j.foodcont.2022.109477.

[7] S. Balasubramanian, R. Kumar, K. K. Singh, et T. J. Zachariah, « Physico-mechanical properties of black pepper (Piper nigrum L.) », 2013.

[8] M. Kashaninejad, A. Mortazavi, A. Safekordi, et L. G. Tabil, « Some physical properties of Pistachio (Pistacia vera L.) nut and its kernel », J. Food Eng., vol. 72, no 1, p. 30-38, janv. 2006, doi: 10.1016/j.jfoodeng.2004.11.016.

[9] T. Goswami et M. Meghwal, « Chemical Composition, Nutritional, Medicinal And Functional Properties of Black Pepper : A Review », J. Nutr. Food Sci., vol. 01, no S1, 2012, doi : 10.4172/scientificreports.172.

[10] CODEX, « Commission du Codex Alimentarius (CSC). Norme pour le poivre noir, blanc et vert (CSX 326-2017). Rome, Italie : Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) et Organisation mondiale de la santé (OMS) ; Codex Alimentarius, Normes alimentaires internationales ; Adoptée en 2017. Amendée en 2021. », 2017.

[11] N. L. W. Meilawati, M. Susilowati, et N. Bermawie, « Phyllogenetic of nine superior black pepper (Piper nigrum L.) varieties based on morphological and molecular markers », IOP Conf. Ser. Earth Environ. Sci., vol. 418, p. 012056, janv. 2020, doi: 10.1088/1755-1315/418/1/012056.

[12] B. Krishnamoorthy et V. A. Parthasarathy, « Improvement of black pepper. », CABI Rev., vol. 2010, p. 1-12, janv. 2010, doi: 10.1079/PAVSNNR20105003.

[13] Devasahayam S., Kandiannan K., Prasath D., Santhosh, Zachariah J.T, et Jayashree E, « (Eds). Black pepper - Extension pamphlett. », ICAR-Indian Inst. Spices Res. Kozhikode Kerala, 2015.

[14] IPC, « Standard specification for black/white pepper (whole and ground) and whole dehydrated green pepper. Jakarta, Indonesia », 2015.

[15] ESA, « European spice association quality minima document. Adopted on 2015, reviewed on 26th March 2018. », 2015.

[16] F. Gu, L. Tan, H. Wu, Y. Fang, et Q. Wang, « Analysis of the blackening of green pepper (Piper nigrum Linnaeus) berries », Food Chem., vol. 138, no 2-3, p. 797-801, juin 2013, doi: 10.1016/j.foodchem.2012.11.033.

[17] M. Weil et al., « Postharvest treatments of wild pepper (Piper spp.) in Madagascar », Fruits, vol. 69, no 5, p. 371-380, sept. 2014, doi: 10.1051/fruits/2014025.

[18] B. Hirko, H. Mitiku, et A. Getu, « Effects of Processing Methods on the Quality of Black Pepper (Piper nigrum L.) », Contemp. Agric., vol. 71, no 3-4, p. 195-202, déc. 2022, doi: 10.2478/contagri-2022-0026.

[19] W.-J. Song, H.-J. Sung, S.-Y. Kim, K.-P. Kim, S. Ryu, et D.-H. Kang, « Inactivation of Escherichia coli O157 :H7 and Salmonella Typhimurium in black pepper and red pepper by gamma irradiation », Int. J. Food Microbiol., vol. 172, p. 125-129, févr. 2014, doi: 10.1016/j.ijfoodmicro.2013.11.017.

[20] B. Hammouti et al., « Black Pepper, the "King of Spices": Chemical composition to applications », 2019.