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EFFECT OF ESSENTIAL OIL OF *MENTHA SPICATA L.* FROM BENIN ON THE QUALITY OF MANGO PUREE IN STORAGE MODEL FOOD SYSTEMS AT 4° AND 25°C

***Euloge S. ADJOU, René G. DEGNON, Bertin A. GBAGUIDI, Edwige DAHOUENON-AHOUSSI, Mohamed SOUMANOU, Dominique C.K. SOHOUNHLOUE**
Laboratory of Research and Study in Applied Chemistry, Polytechnic School of Abomey-Calavi, University of Abomey-Calavi, 01 P.O.B: 2009, Cotonou, Benin
*Corresponding author: eulogesenan@yahoo.fr; euloge.adjou@epac.uac.bj
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Abstract: *The present study aims to evaluate the effect of essential oil from fresh leaves of Mentha spicata L. on the quality of mango puree in storage model food systems at 4°C and 25°C. The results of physico-chemical characterization of mango puree underlined its high nutritional potential, with carbohydrates, carotenoids and vitamin C contents of 9.5±0.4%, 20.05±0.03 mg/100g and 21.03±0.05 mg/100g respectively. The microbiological analyses using taxonomic schemes primarily based on morphological characters of mycelium and conidia revealed that Aspergillus parasiticus, Fusarium versicolor and Mucor spp. were the most common fungi identified in mango puree in the southern Benin. Antifungal assay, performed by the agar diffusion assay, indicated that essential oil exhibited high antifungal activity against the growth of fungi. The minimal inhibitory concentration (MIC) of the essential oil was found to be 2.0 µL.mL^{-1}for Aspergillus parasiticus and Fusarium versicolor; and 1.0 µL.mL^{-1} for Mucor spp. The chemical analysis of the oil made by GC/MS led to the identification of 35 components, characterized by carvone (67.5%), and limonene (12.0%) as major components. The results obtained during the evaluation of the microbiological, physico-chemical and sensorial characteristics of the mango puree stored by adding essential oil, revealed the high potential of the essential oil of Mentha spicata L. in food quality preservation. This essential oil offers a novel approach to the management of fruit derivate products during storage.*

Keywords*: Mentha spicata* L., *plant extract, chemical composition, conservation, Benin.*

1. Introduction

In Africa, several studies reported that the problems encountered by producers during the post-harvest period of agricultural products have been neglected, because they were combined with those related to production. Meanwhile, post-harvest losses are increasing, due to the fact that traditional storage technologies are generally inadequate [1]. Thus, to contribute to the reduction of food insecurity problems, agricultural production should be increased and local products should be valued through the judicious use of technical knowledge and biotechnological tools. For example, the valorization of tropical fruits through their biotransformation into better stabilized and value-added products should be promoted in low income countries.

African flora has a lot of tropical species including mango tree (*Mangifera indica*), whose fruit is highly appreciated for its high content of carotenoids, flavonoids, vitamins and fibers [2]. In Benin, the low valorization of this fruit causes a significant post-harvest loss due to the harvesting or storage conditions that attract many microorganisms and parasites. Thus,

one of the solutions envisaged is its transformation into value-added products, such as mango puree.

However, the conservation of fruit products is a serious problem because of the rapid growth of micro-organisms. To overcome this problem, unspecified heat treatments or antimicrobials products from chemical synthesis are often used. Unfortunately, the nutritional value of fruit derivate products are often modified by heat treatments, and the application in high concentrations of synthetic chemicals products in food preservation increases the risk of toxic residues in food products [3]. Due to the increasing sensitivity of consumers to this residual pollution and the toxic effects of many antimicrobials from chemical synthesis, the importance of using natural products becomes necessary [4]. Similarly, the restriction imposed by the food industry and regulatory agencies on the use of some synthetic food additives has led to a renewed interest in the search for alternatives, such as natural compounds [3].

Plant extracts have many properties, the antimicrobial activity being one of the most important [5]. Many researches have investigated the systematical study of the essential oils extracted from the aromatic plants commonly used in traditional pharmacopoeias in Benin [6, 7], and the importance of the use of essential oils in the food preservation are also reported by Konfo *et al*. [8], Soumanou and Adjou [9], and Adjou *et al.* [10]. The use of essential oils as antimicrobial agents has two main advantages: the first refers to their natural origin which means more safety for the population and environment, and the second is that they are considered to have a low risk of development of resistance by pathogenic microorganisms [11]. Thus, the objective of our study was to evaluate the efficacy of the essential oil extracted from fresh leaves of *Mentha spicata* L. against the spoilage flora of mango puree in Benin by physico-chemical characterization and microbiological analysis.

2. Matherials and methods

Collection of plant leaves

Plant materials used for essential oil (EO) extraction were fresh leaves of *Mentha spicata* L. Plants were collected at Abomey-calavi (6°26′54″ North /2°21′20″ East) (South Benin) and identified at the Benin national herbarium, where voucher specimens are deposited.

Essential oil extraction

The EO tested was extracted by the hydro-distillation method using Clevenger-type apparatus. The oil recovered was dried over anhydrous sodium sulfate and stored at 4 °C until it was used [12].

Gas chromatography–mass spectrometry analysis

The EO were analyzed by gas chromatograph (Perkin Elmer Auto XL GC; Waltham, MA, USA) equipped with a flame ionisation detector, and the GC conditions were EQUITY-5 column (60 m x 0.32 mm x 0.25 µm); H_2 as the carrier gas; column head pressure 10 psi; oven temperature program isotherm 2 min at 70 °C, 3 °C/min gradient 250 °C, isotherm 10 min; injection temperature, 250 °C; detector temperature 280 °C. Gas chromatography–mass spectrometry (GC-MS) analysis was performed using a Perkin Elmer Turbomass GC-MS. The GC column was EQUITY-5 (60 m x 0.32 mm x 0.25 µm); fused silica capillary column. The GC conditions were injection temperature, 250 °C; column temperature, isothermal at 70 °C for 2 min, then programmed to 250 °C at 37 °C/min and held at this temperature for 10 min; ion source temperature, 250 °C. Helium was

the carrier gas. The effluent of the GC column was introduced directly into the source of MS and spectra obtained in the EI mode with 70 eV ionisation energy. The sector mass analyzer was set to scan from 40 to 500 amu for 22 s. The identification of individual compounds is based on their retention times, retention indices relative to C_5 – C_{18} n-alkanes, and matching spectral peaks available in the published data [13].

Collection of mango and puree production

The mango samples used in this study were purchased at the large mango selling area of Dantokpa market in Cotonou (6° 21' 45" North/2° 25' 32" East) (South Benin). These samples consist of ripe mangoes of *Eldon* variety, characterized by a yellow-orange color and a strong aroma of turpentine. Mango samples were washed and pulped. The pulp obtained is chopped and then ground to obtain the mango puree. The Figure 1 shows the technological diagram used for the production of mango puree.

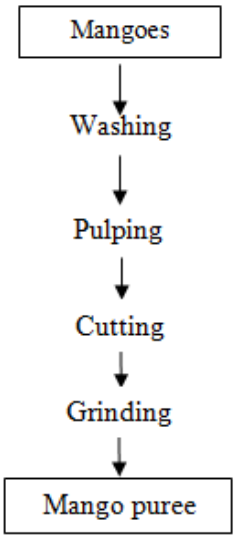

Fig. 1. Technological diagram for mango puree production

Microbiological analysis

For the microbiological analysis, 25 g of sample and 225 ml of peptone water was added and homogenized. From the initial concentration, appropriate decimal dilutions were prepared and aliquots were plated in duplicates on various media. Plate count agar was used for the total bacterial count according to ISO 4833-1 (1) methods. Plates were incubated at 30°C for 72 h. Desoxycholate was used for the total coliforms count according to NF V08-050, and plates were incubated at 30°C for 24 h. Desoxycholate was also used for the faecal coliforms count. In this case, plates were incubated at 44°C and the identification was made using Eosine Methylene Blue (EMB) medium. Bair Parker medium was used for *Staphylococcus spp.* count according to NF EN ISO 6888-1/A1, and plates were incubated at 37°C for 24h. Tryptone sulfite neomycin agar was used for anaerobic sulfito-reducer (ASR) count, according to ISO 7937 methods and tubes were incubated at 37°C for 24 h. After incubation, the number of colonies was tracked, using a colony counter. The number of bacteria expressed as Colony Forming Units per gram (CFU/g) was then determined by calculation, considering dilution factor. All the media used for microbiological analysis were prepared as indicated by the manufacturer. After their isolation, bacteria were also controlled with API System (BioMérieux France).

Fungal isolation

The isolation of fungi from samples was performed using dilution plating method. Ten grams of each juice sample were added separately to 90 ml of sterile water containing, 0.1% peptone water. This was thoroughly mixed to obtain the 10^{-1} dilution. Further, 10fold serial dilutions up to 10^{-4} were made. 1 ml volume of each

dilution was separately placed in Petri dishes, over which, 10 to 15 ml of potato dextrose agar amended with 60 µg/ml chloramphenicol (PDAC) was poured. The plates were incubated at 28 ± 2°C for 7 days. Fungal isolates from PDAC were sub-cultured on malt extract agar (MEA) and identified by using a taxonomic schemes primarily based on morphological characters of mycelium and conidia [10].

Antifungal assay

Antifungal assay was performed by the agar medium assay [5]. Yeast Extract Sucrose medium (YES) with different concentrations of essential oil (0.15, 0.25, 0.50, 0.75, 1.00, 1.50, 2.00, 2.50 $\mu L/mL^{-1}$) and Tween 20 (0.01%) were prepared by adding appropriate quantity of EO to melted medium, followed by manual rotation of flask to disperse the oil in the medium. About 20 ml of the medium were poured into glass Petri dishes (9 cm). Fungal isolates from mango puree on malt extract agar (MEA) are transplanted (subcultured), using a disc of 6 mm in diameter which carries spores from the anamorph mold, on the surface of a Petri dish containing the former medium Yeast Extract Sucrose and EO at different concentrations. Positive Control plates (without EO and inoculated following the same procedure) and negative control plates were also used. Plates were incubated at 25 °C for 5 days.

Determination of the fungistatic or fungicidal activity

With the experimental concentrations where neither growth nor germination was observed, the fungistatic or fungicidal activity was tested. This assay consisted by taking the mycelial disc not germinated at the end of the incubation of the Petri dish and reintroducing it in a new culture medium (former one) without EO. If the mycelial growth is always inhibited, the plant extract is fungicidal at this concentration and allows the determination of the minimum fungicidal concentration (MFC). In the contrary case, it does fungistatic activity which is related to the minimum inhibitory concentration (MIC) [5].

Conservation of mango puree with essential oil

To evaluate the conservation potential of the EO of *Mentha spicata* L., on mango puree, five EO concentrations were tested. These are 0.50, 1.00, 1.50, 2.00 and 2.50 $\mu L/mL^{-1}$. These concentrations were chosen taking into account the high fragrant nature of the EO. A negative control (mango puree without EO) was also produced. Samples were placed at 4°C at 25 °C. After thirty (30) days of conservation at these temperatures, microbiological and physico-chemical qualities of canned mango purees were then evaluated. The pH of the samples was determined in 10ml of mango puree using a digital pH-meter. Vitamin C (l-ascorbic acid) and carotenoids concentrations were determined using method described by Adjou *et al*. [14].

Organoleptic tests

Organoleptic tests were performed using a panel comprising 30 panelists selected on the basis of good health conditions, time availability, no allergy to plant products and their ability to appreciate taste, flavor, color, texture, appearance and after taste. The overall acceptability was determined on a scale by using the 9 point hedonic test as described by Bisla *et al*. [15]. The standard mango puree purchased from retail shops was used as control sample.

Statistical analysis

The experiments were performed in triplicates, and data analyzed are means ± SD subjected to one-way Anova. Means are separated by the Tukey's multiple range test where Anova was significant ($P<0.05$) (SPSS 10.0; Chicago, IL, USA).

3. Results and discussion

By hydrodistillation, fresh leaves of *Mentha spicata* L. yielded 1.85 % of EO. The chemical analysis by GC and GC-MS analysis of EO enabled the identification of 35 components, (Table 1) representing 98.5 % of the EO. In the volatile extract, different groups of terpenes and terpenoids, such as hydrogenated monoterpenes (15.2%) and oxygenated monoterpenes (78.0%) were detected. The EO has chemical composition characterized by carvone (67.5%), and limonene (12.0%) as major components.

The result of microbial analysis and isolation of fungi in pure culture revealed that the most contaminated microflora of mango puree were fungi (Table 2). Fungal isolates include *Aspergillus parasiticus*, *Fusarium versicolor* and *Mucor spp*.

The results of physico-chemical characterization of mango puree (Table 3) indicated that the pH was 6.8±0.1, with carbohydrates, carotenoids and vitamin C contents of 9.5±0.4 %, 20.05±0.03 mg/100g and 21.03±0.05 mg/100g respectively. EO exhibited pronounced antifungal activity against the growth of *Aspergillus spp.*, *Fusarium spp* and *Mucor spp*. The MIC of the EO was found to be 2.0 µl/ml for *Aspergillus parasiticus* and *Aspergillus versicolor*; and 1.0 µl/ml for *Mucor spp.* The MFC was recorded to be 2.5 µl/ml for *Aspergillus parasiticus* and *Fusarium versicolor* and 1.5 µl/ml for *Mucor spp.*

The results obtained during the storage tests of mango puree with the EO of *Mentha spicata* L. at different concentrations (Tables 4 and 5) indicated strong antimicrobial activity of the EO against the spoilage flora, depending on the storage model food system used. Indeed, with the essential oil concentration of 1.50 $\mu L.mL^{-1}$ in a storage model food system of 4°C, there was an important antifungal activity against *Aspergillus parasiticus*, *Fusarium versicolor and Mucor spp.* (Table 4). However, the high antifungal activity of this EO is obtained only with EO concentration of 2.0 $\mu L.mL^{-1}$ in a storage model food system of 25°C (Table 5). Tables 6 and 7 present the results of the evaluation of the physicochemical characteristics of the mango puree conserved by adding EO and stored respectively at 4°C and 25°C. These results indicated a relative stability of physicochemical parameters such as pH, carotenoids and vitamin C contents, in a storage model food system of 4°C and EO concentration of 1.5 $\mu L.mL^{-1}$ after 30 days of storage (Table 6). However, in mango puree stored with EO at concentrations of 0.5 – 1.5 $\mu L.mL^{-1}$, in a storage model food system of 25°C, there was a significant difference in pH, carotenoids and vitamin C contents, after 30 days of storage (Table 7). The results of organoleptic evaluation are shown in Table 8. They indicated that mango puree samples conserved with EO of *Mentha spicata* were found to be organoleptically satisfactory at different concentrations in the tested and stored model food systems used. The comparison of organoleptic quality of mango puree conserved with EO at different concentrations and the standard revealed that mean scores of mango puree conserved with EO were more acceptable than those of the standard. However, it was also observed that the concentration of EO of *Mentha spicata* in samples was inversely proportional to the acceptability

scores. The best overall acceptability scores were identified for EO concentration of 1.5 $\mu L.mL^{-1}$ at 4°C.

Edible fruits become an alternative source of food with high potential of vitamins, minerals and other interesting elements, particularly during seasonal food shortage [16]. They are also known to have nutritional and medicinal properties that can be attributed to their antioxidant effects and they can be used to fortify staple foods particularly for malnourished children [17]. The results of the proximate analyses revealed that mango puree is a good source of carbohydrates, carotenoids and vitamin C. The carbohydrate content was similar to that reported in sour soup fruit [18] and higher than that reported in palmyra juice [14] and in cashew apple juice [19]. The carotenoid content was similar to that reported in palmyra juice [14]. Vitamin C content is lower than those reported in oranges juice [10] and higher than those reported in palmyra juice [14]. The high nutritional potential of mango puree, justified its uses as supplement in infant feeding in Benin. The results obtained from microbial analysis revealed that mango puree was contaminated with microorganisms. The most dominant flora was fungi *Aspergillus parasiticus, Fusarium versicolor* and *Mucor spp*. These fungi species are known as spore formers and their growth can result in the production and accumulation of mycotoxins. The moisture content of mango puree would also encourage microbial growth and so deterioration. The mango puree contamination by fungi does not only reduce its quality, but it may also lead to mycotoxin production [20]. The present study also explores the bioefficacy of EO of *Mentha spicata* L. as the promising plant-based antimicrobial against mango puree-infecting fungal growth. This EO was found to be effective against all *Aspergillus*, and *Mucor* strains tested, and also in the preservation of mango puree quality. This bioefficacy may be due to the presence of some highly fungitoxic components in the oil such as terpenoids. Indeed, *Mentha spicata* oil has a chemical composition characterized by terpenes and terpenoids as the main chemical groups. Several studies have indicated that terpenes do not represent a group of constituents with a high inherent antimicrobial activity. For example, Koutsoudaki *et al.* [21] compared the effect of α-pinene, ß-pinene, p-cymene, ß-myrcene, limonene, and γ-terpinene against *Escherichia coli, Staphylococcus aureus, and Bacillus cereus* and reported that their antimicrobial activity was low or absent. Rao *et al.* [22] also reported that p-cymene and γ-terpinene were ineffective as fungicides against *Saccharomyces cerevisiae*. In contrast, terpenoids are a large group of antimicrobial compounds that are active against a broad spectrum of microorganisms [23]. Their antimicrobial activities are linked to their functional groups and it has also been reported that the hydroxyl group of phenolic terpenoids and the presence of delocalized electrons are important for the antimicrobial activity [23]. The antimicrobial activity of menthol, thymol and linalool, against *Listeria monocytogenes, Enterobacter aerogenes, Eschericha coli, and Pseudomonas aeruginosa* were reported by Bassole *et al*. [24].

These results confirm the high antimicrobial activity of a broad collection of terpenoids, which are the major components of the EO of *Mentha spicata* L. A range of EO components (menthol, thymol, eugenol, carvone, cinnamaldehyde, vanillin, carvacrol, citral, and limonene) has been accepted by the European Commission for their intended use as flavorings in food products [25].

Table 1.

Chemical composition of *Mentha spicata* L. essential oil investigated

Components	Kovats Index	Percentage (%)
α-Pinene	**932**	0.5
Sabinene	969	0.6
β-Pinene	974	0.8
Myrcene	988	0.8
Limonene	**1024**	**12.0**
1,8-cineole	1026	3.6
(Z)-β-ocimene	1032	0.2
ϑ-terpinene	1054	0.2
Linalol	1095	0.5
oct-1-en-3-yl acetate	1110	0.1
neo-alloocimene	1140	0.1
trans-limonene oxide	1137	0.1
cis-chrysanthenol	1160	0.2
δ-terpineol	1166	0.1
cis-dihydrocarvone	1191	0.2
Dihydrocarveol	1192	0.6
neo-dihydrocarveol	1212	0.3
iso- dihydrocarveol	1212	3.4
neoiso-dihydrocarveol	1226	0.1
Carvone	**1239**	**67.5**
Piperitone	1249	0.9
Piperitenone	1343	0.5
Eugenol	1356	0.2
α-copaene	1374	0.4
methyl eugenol	1403	0.1
(Z)-caryophyllene	1408	0.5
β-gurjunene	1431	0.6
α-humulene	1454	0.1
germacrene-D	1484	0 .9
δ-cadinène	1522	0.1
cis-calamenene	1528	0.9
(E)-nerolidol	1561	0.3
caryophyllene oxide	1582	0.4
1,10-di-epi-cubenol	1618	0.4
α-cadinol	1652	0.5
Total		**98.5**

Table 2.

Microbiological quality of investigated mango puree (cfu/mL)

Microbiological parameters	Total bacterial count	Total coliforms count	*E.coli*	*S. aureus*	A.S.R. count	Yeast count	Fungi count
Mango puree sample	4.7×10^2	00	00	00	00	00	8.1×10^1

Table 3.

Physicochemical quality of investigated mango puree

Physico-chemical parameters	pH	Carbohydrates (%)	Vitamin C (mg/100g)	Carotenoids (mg/100g)
Mango puree sample	6.8±0.1	9.5±0.4	21.03±0.05	20.05±0.03

Table 4.

Microbiological quality (ufc/ml) of investigated mango puree after 30 days of conservation at 4°C

	Concentrations of essential oil ***(µl/ml)***					
Parameters	***0***	***0.50***	***1.00***	***1.50***	***2.00***	***2.50***
Total bacterial count	$2.0x10^{3a*}$	$1.0 \times 10^{3b*}$	10^{1c*}	00^{d*}	00^{e*}	00^{e*}
Fungi count	$1.7.0x10^{3a*}$	$2.0 \times 10^{2a*}$	10^{1b*}	00^{c*}	00^{d*}	00^{d*}

*Values are means. The means followed by same letter in the same line are not significantly different according to ANOVA and Tukey's multiple comparison tests.

Table 5.

Microbiological quality (ufc/ml) of investigated mango puree after 30 days of conservation at 25°C

	Concentrations of essential oil ***(µl/ml)***					
Parameters	***0***	***0.50***	***1.00***	***1.50***	***2.00***	***2.50***
Total bacterial count	$3.0x10^{7a*}$	$2.0 \times 10^{5b*}$	10^{2c*}	10^{d*}	00^{e*}	00^{e*}
Fungi count	$1.0x10^{5a*}$	$1.0 \times 10^{2a*}$	$1.2 x10^{1b*}$	10^{c*}	00^{d*}	00^{d*}

*Values are means. The means followed by same letter in the same line are not significantly different according to ANOVA and Tukey's multiple comparison tests.

Table 6.

Physico-chemical quality of investigated mango puree after 30 days of conservation at 4°C

Physico-chemical parameters	**Mango puree 's characteristics at the beginning of the conservation tests**	**Characteristics of the mango puree after 30 days of conservation**					
		Concentrations of essential oil (µl/ml)					
		0	***0.50***	***1.00***	***1.50***	***2.00***	***2.50***
pH	$6.8±0.1^{a*}$	$4.5±0.1^{b*}$	$4.97±0.30^{b*}$	$5.7±0.2^{b*}$	$6.2±0.3^{a*}$	$6.21±0.10^{a*}$	$6.22±0.80^{a*}$
Carbohydrates (%)	$9.5±0.4^{a*}$	$2.97±0.10^{b*}$	$5.85±0.20^{c*}$	$6.5±0.1^{c*}$	$9.4±0.1^{a*}$	$9.43±0.10^{a*}$	$9.42±0.20^{a*}$
Carotenoids (mg/100g)	$20.05±0.03^{a*}$	$5.91±0.07^{b*}$	$9.09±0.03^{c*}$	$11.73±0.01^{d*}$	$18.03±0.05^{a*}$	$18.05±0.03^{a*}$	$19.07±0.03^{a*}$
Vitamin C (mg/100g)	$21.03±0.05^{a*}$	$3.09±0.02^{b*}$	$4.08±0.09^{c*}$	$11.01±0.03^{d*}$	$20.04±0.07^{a*}$	$20.09±0.04^{a*}$	$21.01±0.05^{a*}$

*Values are means. The means followed by same letter in the same line are not significantly different according to ANOVA and Tukey's multiple comparison tests.

Table 7.

Physico-chemical quality of investigated mango puree after 30 days of conservation at 25°C

Physico-chemical parameters	Mango puree 's characteristics at the beginning of the conservation tests	Characteristics of the mango puree after 30 days of conservation					
		Concentrations of essential oil (µl/ml)					
		0	***0.50***	***1.00***	***1.50***	***2.00***	***2.50***
pH	6.80±0.10[a]	2.40±0.10[b]	4.90±0.40[b]	5.40±0.60[b]	5.70±0.20[c]	6.20±0.30[a]	6.23±0.70[a]
Carbohydrates (%)	9.50±0.40[a]	1.80±0.20[b]	5.70±0.30[c]	6.20±0.10[c]	8.10±0.60[d]	9.40±0.10[a]	9.39±0.30[a]
Carotenoids (mg/100g)	20.05±0.03[a]	4.51±0.07[b]	9.06±0.04[c]	11.53±0.02[d]	14.03±0.06[e]	18.03±0.05[a]	19.02±0.07[a]
Vitamin C (mg/100g)	21.03±0.05[a]	1.06±0.03[b]	4.07±0.09[c]	10.01±0.04[d]	12.08±0.07[d]	20.04±0.07[a]	21.01±0.03[a]

Values are means. The means followed by same letter in the same line are not significantly different according to ANOVA and Tukey's multiple comparison tests.

Table 8.

Results of organoleptic evaluation of mango puree preserved with EO of *Mentha spicata*

	Type of Mango purees	Appearance	Color	Texture	After taste	Overall acceptability
	Standard	8.12 ± 0.57	7.04 ± 0.29	7.57 ± 0.42	8.29 ± 0.15	8.38 ± 0.14
Storage at 4°C	***Samples A*** *(conserved with 1.5 $\mu L.mL^{-1}$ of EO)*	8.27 ± 0.24	8.32 ± 0.57	8.4 ± 0.23	8.40 ± 0.21	8.74 ± 0.26
	Samples B *(conserved with 2.0 $\mu L.mL^{-1}$ of EO)*	8.20 ± 0.13	8.27 ± 0.62	8.02 ± 0.74	8.25 ± 0.32	8.60 ± 0.19
	Samples C *(conserved with 2.5 $\mu L.mL^{-1}$ of EO)*	8.10 ± 0.82	8.04 ± 0.52	7.82 ± 0.54	8.16 ± 0.11	8.45 ± 0.65
Storage at 25°C	***Samples D*** *(conserved with 2.0 $\mu L.mL^{-1}$ of EO)*	8.17 ± 0.51	8.32 ± 0.72	8.3 ± 0.71	8.37 ± 0.54	8.69 ± 0.37
	Samples E *(conserved with 2.5 $\mu L.mL^{-1}$ of EO)*	7.63 ± 0.25	8.29 ± 0.43	8.07 ± 0.56	8.28 ± 0.62	8.73 ± 0.39

All values are found to be nonsignificant.

The United States Food and Drug Administration (FDA) also classify these substances as generally recognized as safe (GRAS). In our study, GC–MS data depicted remarkable variation in the earlier reports on the oils [24, 26]. The chemical profile of EO is reported to be influenced by the harvest period, and by climatic, seasonal, and geographical conditions, which can significantly affect the amount and composition of the active constituents [27]. Thus, the biologically activity of EOs should be qualitatively standardized before their recommendation for practical exploitation as has been done in the present investigation. The results of the organoleptic evaluation revealed that the use of EO of *Mentha spicata* in other to preserve the quality of mango puree does not have a negative impact on the sensorial characteristics, such as appearance, color, texture, after taste of the canned mango

purees and its overall acceptability was determined by panelists during the degustation tests. In the available literature, many areas of food science are concerned with the use of essential oils.
In food products, essential oils have been used in bakery [28], cheese [29] and fruit [30], among others. However, many of individual oil components used as approved food flavorings can also impart a certain flavor to foods. Then, the organoleptic impact on treated food must also be evaluated, as it has been done in the present investigation.

4. Conclusions

This work underlined the bioactivity of EO of fresh leaves of *Mentha spicata* L. from Benin as a fungal growth suppressor in mango puree.
Based on its antifungal potential, this natural plant product may successfully replace synthetic chemicals and provide an alternative method to the preservation of mango puree as well as of other fruit derivate products with high nutritional significance against the contamination and growth of bacteria and fungi.

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Conflicts of interest: none.

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