

**Use of *Cymbopogon citratus* essential oils for preservation of *Fragaria ananassa* after conventional harvesting**

Aplicación de los aceites esenciales de *Cymbopogon citratus* para la conservación de *Fragaria ananassa* después de la cosecha convencional

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## ABSTRACT

**Introduction:** *Fragaria ananassa* (strawberry) requires the use of preservation methods after being harvested. Application of essential oils from *Cymbopogon citratus* (DC) Staf (lemon grass) is an alternative for chemical treatment of the fruit.

**Objectives:** Evaluate the preservation of strawberries cv. Albion obtained from organic harvesting and conventional agriculture after being soaked in *C. citratus* oil to compare the physicochemical and organoleptic characteristics of the fruit.

**Methods:** The strawberries were soaked in a lemon grass essential oil solution (0.001%) for one minute and were kept in a cold environment (4°C) for 24 hours. The variables analyzed were total soluble solids, pH, titratable acidity, maturation index, weight loss, total phenolic compounds,

anthocyanins and organoleptic analysis. The experiment was based on randomized block design and a factorial scheme of 2 x 2, 3 replications.

**Results:** Determination was made of greatest acidity (0.45% citric acid) and smallest weight loss, maturation index (16.39), and the content of phenolic compounds (gallic acid 165.06 mg/100 g<sup>-1</sup>) and anthocyanins (100 g/61.93 mg<sup>-1</sup>) in the conventional fruits soaked in the lemon grass essential oil solution.

**Conclusions:** Application of lemon grass essential oil was effective to maintain the quality of the fruit after being harvested. Additionally, conventional strawberries were found to have better physicochemical quality than organic strawberries.

**Keywords:** *Fragaria ananassa* Duch; storage; essential oils; phenolic compounds.

## RESUMEN

**Introducción:** *Fragaria ananassa* (fresa) requiere el uso de métodos de conservación después de la cosecha. La aplicación de aceites esenciales de *Cymbopogon citratus* (DC) Staf (hierba de limón) es una alternativa para el tratamiento químico de la fruta.

**Objetivos:** Evaluar la conservación de la fresa cv. Albion de la cosecha procedente de la producción orgánica y de la procedente de la agricultura convencional después de la inmersión en aceite de *C. citratus* para comparar las cualidades físico-químicas y sensoriales de la fruta.

**Métodos:** Las fresas se sumergieron en una solución del aceite esencial de la hierba de limón (0,001 %) durante un minuto y se mantuvieron en frío (4 °C) durante 24 horas. Las variables analizadas fueron: sólidos solubles totales, pH, acidez titulable, índice de maduración, pérdida de peso, compuestos fenólicos totales, antocianinas y análisis sensorial. El experimento fue diseñado en bloques aleatorios y esquema factorial 2 x 2, 3 repeticiones.

**Resultados:** Se verificó mayor acidez (0,45 % ácido cítrico) y menor pérdida de masa, se calculó el índice de maduración (16,39), se comprobó la presencia de compuestos fenólicos (ácido gálico 165,06 mg/100 g<sup>-1</sup>) y se estimó el contenido de antocianinas (100 g/61,93 mg<sup>-1</sup>) en las frutas convencionales sumergidas en la solución de aceite esencial de hierba de limón.

**Conclusiones:** La aplicación del aceite esencial de la hierba de limón fue eficaz para mantener la calidad de la fruta después de la cosecha. Además de eso, las fresas convencionales tenían una mayor calidad físico-química en comparación con las orgánicas.

**Palabras clave:** *Fragaria ananassa* Duch; almacenamiento; aceites esenciales; compuestos fenólicos.

Recibido: 03/05/2017

Aprobado: 11/04/2019

## INTRODUCTION

The tripping plant, the Rosaceae family and genus *Fragaria ananassa*,<sup>(1)</sup> the eatable part is the strawberry. It is a accessory fruit temperate climate featuring bright red color, peculiar odor, slightly sour flavor and soft texture.<sup>(2)</sup> Strawberries contain high levels of phenolic compounds, including anthocyanins and high content of soluble solids.<sup>(3,4,5)</sup>

Worldwide, strawberries production reaches an estimated 7.74 tonnes per year.<sup>(6)</sup> The culture of this fruit is characterized predominantly by family labor on small farms and has the potential to significantly increase income and employment in the field, demonstrating high socioeconomic importance.<sup>(7)</sup> The strawberry is considered a result of difficult conservation due to its high metabolic rate and high susceptibility to pathogen attack. Fungal infections are the most responsible for diseases and post-harvest losses in these fruits,<sup>(8)</sup> which also occur by improper handling and storage and mechanical injuries.<sup>(9)</sup> The main losses occurring in the postharvest period of fruits are related to nutritional and sensory qualities.<sup>(10)</sup>

Commonly chemicals are used to maintain the postharvest quality strawberries, however the use of these compounds can cause food toxicity and environmental.<sup>(8)</sup> As a result, there is a growing demand for alternative conservation methods to maintain the physical and chemical aspects, nutritional and sensory present in post-harvest these foods. In this context, the use of essential oils for medicinal plants and herbs is considered a viable and sustainable alternative for the maintenance of postharvest quality.<sup>(11)</sup> The essence of lemongrass oil is an oily, volatile liquid, which has as its main constituent citral, which is responsible for antioxidant activity and fungitoxic.<sup>(12)</sup> The use of essential oils from herbs, including lemongrass has economic importance due to the versatility of the use of oil and is used in cosmetics, pharmaceuticals and food production.<sup>(13)</sup> The actions, antimicrobial, cytotoxic, and fungistatic these oils explain the wide use of them.<sup>(14)</sup> Regnier<sup>(15)</sup> observed after the use of essential oil of lemongrass (1000 uL L<sup>-1</sup>) in the control of diseases and rot in 'Valência' oranges fungistatic oil.

In this context, the objective of this study was to evaluate the strawberry postharvest conservation farming Albion neutral days, coming from organic and conventional production, after immersion in essential oil of *Cymbopogon citratus* (lemongrass), comparing the physicochemical qualities chemical and sensorial fruit.

## METHODS

The conventional cultivation of strawberries was obtained in the local market, while the organic cultivation of strawberries was from Producer Regional Fair Guarapuava-Br and conventional fruit production in São José dos Pinhais / PR, in the amount of two kilograms of each cultivation. The study was conducted in Postharvest Fruit and Vegetables Laboratory of the UNICENTRO Agronomy department, campus CEDETEG, in February and March 2015. The selected fruits were previously cleaned in running water for withdrawal of dirt and immersed in the sodium hypochlorite solution at 1 % for 30 minutes. After, there was new wash under running water.

Organic and conventional fruits were packed in polystyrene trays of 23.5 cm x 18 cm. Soon after, they were organized into four different treatments: a) organic management with essential oil of lemongrass; b) organic management without essential oil of lemongrass, it was added 500 mL of water (control); c) conventional management with essential oil of lemongrass and; d) conventional management without essential oil of lemongrass, containing 500 mL water (control). The essential oil of lemongrass solution was prepared at 0.001 %, using 50  $\mu$ L of the essential oil and 125  $\mu$ L of the natural adjuvant (LI 700, Fortgreen®) added 499.95 ml of distilled water two of strawberries. The treatments were immersed in the essential oil of lemongrass solution for 1 minute, and then kept under refrigeration at  $4^{\circ}\text{C} \pm 2$  for 24 hours for further analysis.

The following analysis on fruits were performed, total solids content: was determined using a portable digital refractometer (Atago®, Brazil),<sup>(14)</sup> pH: was determined by direct measurement of pH meter (Dellta®, Brazil);<sup>(15)</sup> titratable acidity was checked by titration with NaOH 0.1 mol L<sup>-1</sup>;<sup>(16)</sup> maturation was index established by the relationship (ratio) of soluble solids between titratable acidity (SS / TA),<sup>(17)</sup> Loss of mass theoretically calculated by % weight loss = (initial weight-final weight \* 100) / (initial weight). The initial weight was measured before and at the end of fruit receiving treatment; total phenolic compounds analyzed by a spectrophotometer (740 nm), according to the methodology of Woisky and Salantino,<sup>(18)</sup> Total anthocyanins by the pH differential method proposed by Giusti and Wrolstad,<sup>(19)</sup> read with a spectrophotometer (505 nm and 700 nm).

For the sensory analysis, the strawberries were processed in a centrifuge (Britânia®, Brazil) and served shredded in white plastic cups coded with three-digit numbers, balanced and randomized to form, together with water for carrying out white. A sort of test was used to compare the differences of the samples in taste, appearance and preference.<sup>(20)</sup> In this test 50 tasters, of both sexes, classified the samples in descending order, with the more pleased for the least pleased the specified criteria. The judges were given 15 mL from each sample. This work was approved by the Ethics Committee of the UNICENTRO, opinion number 107698/2014.

The study was designed in factorial 2 X 2 (two crops system with and without essential oil), with three replicates, each replicate consisting of four fruits. Data were normal analysis and homogeneity of variance and mean comparison Tukey test ( $p < 0.05$ ) using SISVAR® software. The data in the sensory analysis were statistically analyzed using the Friedman Test.<sup>(16)</sup>

## RESULTS

Table 1 shows the results found in soluble solids analysis (SS), titratable acidity (TA), SS / TA, pH and weight loss (%). The soluble solids analysis showed no difference between organic and conventional management systems or between treatments. For the titratable acidity there was no interaction between the factors, management (organic and conventional) and addition of the essential oil, however, there was significance only for the addition of essential oil factor. The titratable acidity increased 18 % in treatments with addition of the essential oil when compared to the treatments that did not receive the essential oil.

For the maturation index, there was interaction between the factors (management and application of the essential oil), and strawberries from organic management without essential oil application had a higher maturation index. While the fruits obtained from the organic management with application of essential oil had a lower maturation index. The conventional management there was no significant difference.

Strawberries conventional production system showed higher front maturation index to organic fruit when treated with essential oil of lemongrass, with a significant difference between the averages ( $p < 0.05$ ). The weight loss was significantly greater for strawberries coming from organic farming system, when compared to conventional fruits

**Table 1** - Soluble solids (SS), titratable acidity (TA), SS / TA, pH and weight loss (%) of organic and conventional strawberries treated and untreated with essential oil of lemongrass

Features	Treatment	Management		Average of treatments
		Organic	Conventional	
SS (°Brix)	With oil	5.1	7.3	6.2
	No oil	6.1	5.7	5.9
TA (mg citric acid 100 g <sup>-1</sup> )	With oil	0.45	0.46	0.45 <sup>a</sup>
	No oil	0.38	0.38	0.38 <sup>b</sup>
	With oil	11.1 Ab	16.4 Aa	13.75
SS/TA	No oil	16.2 Aa	15.2 Ba	15.70
	With oil	3.5	3.4	3.45
pH	No oil	3.4	3.5	3.45
	With oil	0.45 Ab	0.00 Bb	0.22
Weight loss (%)	No oil	5.04 Aa	2.23 Aa	3.63

Capital letter in the column and lowercase in the row.

In relation to fruit untreated and analyzing the system from which they are derived, organic contents were lower phenolics against the conventional compounds. It was observed that among the fruits treated with essential oil there was no difference between organic and conventional management for phenolic compounds and total anthocyanins (Table 2).

**Table 2** - Phenolic compounds and total anthocyanins of organic and conventional strawberries treated and untreated with essential oil of lemongrass

	Treatment	Management	
		Organic	Conventional
Phenolic compounds (mg gallic acid 100g <sup>-1</sup> )	With oil	158.6aB	198.6aA
	No oil	116.4b	131.5b
Anthocyanins (mg 100g <sup>-1</sup> )	With oil	61.9	62.6b
	No oil	64.7B	111.1aA

Capital letter in the column and lowercase in the row.

## DISCUSSION

In the present study the different managements presented similar values for the solid soluble variable. In research developed by *Borges*<sup>(21)</sup> found similar results with no difference in soluble

solids content of strawberries receiving coating xanthan gum and essential oil of sage, other possible alternatives used in post fruit harvest conservation.

The lemon grass essential oil increased the acidity titratable in strawberry fruits regardless of the management performed, probably the essential oil of lemon grass has terpenic substances such as citral and myrcene.<sup>(12)</sup> According to *Felipe*<sup>(13)</sup> terpene substances are directly related to the color and aroma of fruits, besides being known for their antimicrobial and antioxidant action.<sup>(14)</sup> This may explain the increase in titratable acidity in strawberries that have been treated with essential oil, thus keeping the product viable for consumption for a longer period of time.

The fruit of the organic management with the non-application of the essential oil showed the best balance between the sweet and sour taste, beside that these fruits can be shorter shelf life when compared to the organic fruits treated with essential oil. This result may be related to the titratable acidity that the organic fruits treated with essential oils presented.

This ratio expresses the sugar/acid, which gives flavor to the fruit. *Hallmann*,<sup>(22)</sup> which indicated significant influence of organic production system on the same variable in tomatoes. *Lima*<sup>(23)</sup> used ozonated water as an alternative sanitizer to pesticides in the treatment of broccoli the same production systems and found also value greater maturation index those of conventional sources.

Related to the quantification of pH, no differences were found between treatments and managements. *Vieira*<sup>(24)</sup> studied the physicochemical quality mini-tomatoes (sweet grapes) produced in organic and conventional farming systems and also found no significant difference in pH between the two systems.

In present study, it was noticed that treated fruits in immersion for one minute in essential oil of lemongrass reduced in both systems, the mass loss when compared to untreated strawberries. However, *Perdones*<sup>(25)</sup> using essential oil of lemon in chitosan strawberry storage quality, the fruits of conventional origin had reduced the percentage mass loss after treatment when compared to organic fruits.

The content of phenolic compounds was higher in treated strawberries when compared to untreated, coinciding with the results presented by *Jin*<sup>(26)</sup> with raspberries treated with different essential oils containing carvacrol, anethol, cinnamic acid, among others found in oregano. In research developed by *Borguini*<sup>(27)</sup> who found in tomatoes, the largest amount of total phenolic compounds those of organic origin when compared to conventional.

The total anthocyanins are found in greater quantity in strawberries conventional system. *Kovačević*<sup>(28)</sup> found no significant differences of anthocyanins in organic and conventional strawberries. The application of essential lemongrass oil in the fruits, both conventional and organic, reduced reading spectrophotometer values of anthocyanins of strawberries. This result disagrees with the findings of *Mazaro*<sup>(29)</sup> comparing different formulations and extracts of *Calendula officinalis* L. based on strawberries and found no significant differences for the studied factors and the interaction of them.

The results in sensory analysis showed no significant difference in the treatment and management strategies for the appearance criteria, flavor and overall preference of the pulp of each sample offered to tasters. This finding may be explained by the fact that appearance and taste are directly linked to fruit maturation index,<sup>(30)</sup> and this variable did not show significant difference in fruit which did not receive treatment with essential oil lemongrass. Furthermore, appearance and taste influence the choice of the consumer preference for a product.

The use of essential of lemongrass oil in strawberries is a viable option to maintain postharvest quality of the fruit, as there was less reduction in acidity, which indicates reduced metabolic activity and consequent interference in the maturation index. Besides that, in fruits treated essential oil of *Cymbopogon citratus* (lemongrass) the weight loss was significantly lower and the higher phenolic content. Sensory analysis showed no significant difference between organic and conventional management systems or between treatments, this being another reason for the use of essential lemongrass oil in post-harvest strawberries quality. The conventional tillage system indicated a greater physical chemical quality of strawberries compared to organic.

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### **Conflicto de intereses**

Los autores expresan que no existe conflicto de intereses.

### **Contribución de los autores**

Thiécla Katiane Rosales Silva participated in planning, execution, statistical analysis, writing and review.

Débora Hitz and Aline José Maia participated in the execution, writing and review.

Kélin Schwarz, Daiana Novello and Virlene do Amaral participated in writing and review.