EFFECT OF CINNAMON WITH OR WITHOUT POTASSIUM SORBATE OR LACTIC ACID, PACKAGING MATERIAL AND STORAGE TEMPERATURE ON THE SHELF LIFE OF CROISSANT

EL- ANANY, A. M. AND HALLA, M. Z. M.

Food Technology Research Institute, ARC. Ministry of Agriculture, Giza, Egypt.
(Manuscript received 8 October 2006)

Abstract

Each of ground cinnamon, potassium sorbate, lactic acid or their mixtures was used as preservatives in croissant pastries. Cinnamon was added at levels of 0.5, 1.0 and 1.5% of flour weight and as combined with 0.1% of either potassium sorbate or lactic acid. The results show that cinnamon at a level 1.5% had a good effect as an antimicrobial and antioxidant agent. However the combinations of 1.5% cinnamon with lactic acid or potassium sorbate was more effective in extending the shelf life of croissant samples than using 1.5% cinnamon alone. Packaging in polypropylene bags was more protective compared with polyethylene bags. Croissant samples stored at 10° C ±, 1° C had a longer shelf life more than those stored at room temperature.

INTRODUCTION

Bakery products are important in the daily diet .A wide variety of such products can be found on the supermarket shelves. Smith, *et al.* 2002 stated that bakery products like many processed foods are subject to physical, chemical and microbiological spoilage. While physical and chemical spoilage limit the shelf-life of low and intermediate moisture bakery products, microbiological spoilage by bacteria, yeast and fungi is the main concern in high-moisture products. Cookouts, *et al.* 2004 reported that the control of the growth of microorganisms of the spoilage and safety concern in high-moisture bakery products was most commonly achieved using chemical preservatives, specifically sorbic and prop ionic acids and their salts.

Antimicrobial properties of cinnamon have been presented by Bullerman, (1974) who showed that 1% ground cinnamon in raisin bread significantly reduced the growth of *Aspergillus parasiticus* and aflatoxin production. Also ground cinnamon at 2% was effective by more than 95% in preventing the formation of aflatoxins B_1 and G_2 in vitro.

Ueda, *et al.* 1982 also stated that cinnamon exhibited a wide inhibitory spectrum of microorganisms.

The antimicrobial activity of mastic resin against several food borne pathogens, many yeasts and molds has been reported by many authors (Alippiet, *et al.* 1996 and Huwez *et al.* 1998). Uattara and others (1997) examined the inhibitory properties of

cinnamon essential oil against meat spoilage bacteria, *Cranobacterium* piscicola, *Lactobacillus curavalus, Lactobacillus sake, Brochothrix thermophacta ,Pseudomonas fluorescens* and *Serratia liquefaciens*. The results of their study showed that cinnamon essential oil exhibited a remarkable inhibitory effect .

Ceylar *et al.* 2004 examined the antimicrobial effects of cinnamon, sodium benzoate, potassium sorbate and their combinations against *Escherichia coli O 157:H 7* in apple juice. The results of this investigation showed that a synergistic effect was observed between cinnamon and the chemical preservatives against *E. coli O 157:H 7* at 8° C and 25° C .

The objective of this investigation was to study the antimicrobial and antioxidant activities of cinnamon and the synergistic effect of combinations of cinnamon with potassium sorbate or lactic acid in preserving croissant which is considered a high-fat, high moisture bakery product .The effect of packaging material and storage temperature on the self life of croissant were also studied

MATERIALS AND METHODS

Flour 72% extraction rate was obtained from Flour Land Co. 6th October City Giza, Egypt. Ground cinnamon, shortening, sugar, skim milk powder, egg, salt and dry yeast were obtained from local market. Potassium sorbate, and lactic acid were obtained from El-Gomhoria Co. Cairo, Egypt.

Croissant pastry preparation

Dough was prepared according to the method described by Sternhagen and Hoseney (1994). The ingredients were 1kg flour, 15g salt, 15g yeast, 100g sugar, 40g skim milk powder and sufficient water to make cohesive dough constant consistency after mixing, then the dough was left to rest for 15 min., before incorporating 500g of layering fat by envelope method. The paste was left to rest for another 15min. and gauged to 10mm. thickness by using a sheeter. To make further lamination a combination of two method of rolling was followed. In the first the sheet was folded into 3 layers (threefold), then the paste was left to rest in a refrigerator for 15 min. In the second, the sheet was gauged to 8 mm. and then the ends were folded first and then folded again like a book (book turn, or fourfold), after another 15min. of resting , the paste was gauged to 7mm thickness and given two fourfold turns before final gauging to 3-6mm. The paste was cut into triangular pieces. The pastries were placed into a proofing cabinet and proofed at a relative humidity of 85% and a temperature of 38° C for 60min. The pastries were baked at 190° C for 8 min. and allowed to cool at room temperature. The Ground cinnamon was added into flour at 0.5%, 1.0% or

1.5% (wt/wt) levels to evaluate the antimicrobial and antioxidant properties of cinnamon.

Potassium sorbate or lactic acid at a level of 0.1%of the flour weight were added in combination of each of the above-mentioned levels of ground cinnamon to evaluate their synergistic effects against the growth of microorganism .Other treatments were prepared containing potassium sorbate (0.1%) or lactic acid (0.1%) along with a control treatment ,without added any cinnamon ,for comparison

Microbiological assay

Total microbial count, yeast and mold count, *Salmonella*, *Staphylococcus aureus, Shigella and Coliforms* were determined according to A.O.A.C.(2000).

Chemical analysis

Peroxide value and thiobarbituric acid (TBA) of oil extracted from croissant samples were determined according to A.O.A.C. (2000) and Sidwell *et al.* (1954), respectively .

Storage experiment

The croissant pastry samples were packed in polyethylene and polypropylene metallized film and stored at room temperature (30°C ± 5°)and (10° C± 1°). to evaluate the effect of the packing materials and the temperature on the shelf life of this product.

Statistical analysis

The data of the present work were subjected to analysis of variance and the least significant difference (LSD) test was calculated to allow comparison between the mean values of the investigated parameters (Cochran and Cox 1992).

RESULTS AND DISCUSSION

Detection of pathogens

The croissant samples were found to be free of the microbial growth as well as the *Salmonella, Staphylococcus aurues, Shigella and coliforms* after baking through the storage period and until the deterioration of the samples under investigation.

This reflected good manufacturing practice and proper sanitation conditions applied through preparing, baking, packing, handling and storage of the croissant. The absence of the above-mentioned microorganisms indicated a high quality and safe final product.

Changes in the microbial count upon storage at room temperature

The results presented in Tables 1 and 2 indicated that croissant samples containing different levels of cinnamon (0.5, 1.0 and 1.5% of flour weight) had a longer shelf life compared with the control sample (free of cinnamon and

preservatives). The length of shelf life was gradually increased by increasing the level of cinnamon added to the croissant samples. This effect is due to that cinnamon contains numerous compounds that have inhibitory properties against the growth of microorganism *(Bullerman, 1974, Ouattara et al (1997) and Ceylan et al. (2004).* On the other hand, a synergistic effect was demonstrated in the combinations of 0.5, 1.0 and 1.50% of ground cinnamon with 0.1% of either of potassium sorbate or lactic acid

The shelf life of croissant samples stored at room temperature was extended to 21 and 22 days in samples containing 1.5% cinnamon and 0.1 potassium sorbate and packed in polyethylene and polypropylene bags, respectively. Results also noted that the croissant samples containing 1.5% cinnamon and 0.1 lactic acid had relatively long shelf life was 18 and 21 days of samples packed in polyethylene and polypropylene bags, respectively. Accordingly, it is recommended to add 1.5% cinnamon and 0.1% potassium sorbate or lactic acid to flour used in preparing croissant and to use polypropylene bags as a packaging material to extend the shelf life of croissant when stored at room temperature.

Effects of storage at 10°C ± 1°C

The temperature of storage room play a critical role in the shelf life of food products. Data presented in Tables 3 and 4 show that control samples (free of cinnamon and preservatives) were found to be free of the microbial growth until 10 days of storage at 10°C ± 1°C. In the same time the shelf life of these samples was extended to 42 and 45 days for croissant samples packed in polyethylene and polypropylene bags, respectively. Meanwhile the growth of these microorganisms was only detected after 40 days in croissant samples containing different levels of ground cinnamon. The synergistic effects of the combinations of ground cinnamon with potassium sorbate or lactic acid were shown in decreasing the growth of microorganisms.

Effect of cinnamon at different levels on the rate of lipid oxidation of croissant samples stored at room temperature or at 10°C

An important chemical spoilage reaction that takes place during the storage period is oxidation .The atmospheric oxygen reacts with the oil at its surface (attacks the double bonds causing oxidation producing hydro peroxides (flavorless), which can further undergo three major types of degradation (1) fission, which produces alcohols, aldehydes ,acids and hydrocarbons,

(2) dehydration, which produces ketones, and (3) free radical formation, which produces oxidized monomers, oxidative dimmers and polymers,trimers, epoxides, alcohols, hydrocarbons, non-polar dimers and polymers *(Perkins,1988).*

These by-products of oxidation can produce off flavors *(Miller,1993).* In his respect hydroperoxides are the primary products of lipid oxidation, therefore,

determination of peroxides can be used as an oxidation index for the early stages of lipid oxidation .Tables 5,7and8 illustrate the changes in the peroxide values of the oil extracted from croissant samples under investigation .Generally, there were gradual increases in the peroxide values during storage period at room temperature and cold temperature10º C±1 º C .Data also indicated that the peroxide values of croissant samples stored at room temperature were higher than those stored at cold temperature .In addition, the higher levels of cinnamon induced the highest antioxidant activity .In fact samples containing 1.5% cinnamon had the lowest peroxide values .These results in a good agreement with those obtained by *Farag et al.,(1989) and Topallar et al.,(1997).* It is well known that carbonyl compounds are formed as secondary oxidation products from the decomposition of hydro peroxides during fat and oil heating.

The carbonyl compounds react with TBA to yield TBAC derivatives that have a high absorbance at 550nm *(Orthoefer and Cooper,1996).* Tables 6,9and 10illustrate the changes in the TBA values of the oil extracted from croissant samples under investigation . In general, there were gradual and significant increases in TBA values .Meanwhile, various concentrations of cinnamon had values lower than those samples free of cinnamon. The croissant samples that contain 1.5%cinnamon and stored under cold or room temperatures had the lowest TBA values.

This reflects that ground cinnamon has a high antioxidant activity.

Table 1. Effect of cinnamon (C), potassium sorbate (S), lactic acid (L) or combinations of them on the microbial count of Croissant packed in polyethylene bags and stored at room temperature.

Storage period (days) / treatments	Zero time bacteria, yeast and molds CFU/gm	4		8		12		16		20	
		Bacteria CFU/gm	Yeast and molds CFU/gm	Bacteria CFU/gm	yeast and molds CFU/gm	Bacteria CFU/gm	yeast and molds CFU/gm	Bacteria CFU/gm	yeast and molds CFU/gm	Bacteria CFU/gm	yeast and molds CFU/gm
control	ND	$1.0 \times 10^{2\,a}$	$1.2 \times 10^{2\,a}$	Ex 6 daysth							
0.5 C	ND	3×10^{a}	6×10^{b}	8×10^{a}	9×10^{a}	Ex 9 daysth					
1.0 C	ND	ND^{c}	2×10^{c}	6×10^{b}	7×10^{b}	Ex 11daysth					
1.5 C	ND	ND^{c}	1×10^{c}	3×10^{c}	4×10^{c}	6×10^{ab}	$1.1 \times 10^{2\,b}$	Ex 15 daysth			
0.1 S	ND	ND^{c}	1×10^{c}	ND	2×10^{d}	9×10^{a}	$1.2 \times 10^{2\,a}$	Ex 13 daysth	Ex 13 daysth		
0.1 L	ND	ND^{c}	2×10^{c}	ND	4×10^{c}	8×10^{a}	$1.1 \times 10^{2\,b}$	Ex 13 daysth	Ex 13 daysth		
0.5 C + 0.1S	ND	ND^{c}	ND^{e}	ND	1×10^{e}	8×10^{a}	$1.1 \times 10^{2\,b}$	Ex 14 daysth			
1.0 C + 0.1S	ND	ND^{c}	ND^{e}	ND	ND^{f}	7×10^{ab}	$1.0 \times 10^{2\,b}$	Ex 16 daysth			
1.5 C + 0.1S	ND	ND^{c}	ND^{e}	ND	ND^{f}	4×10^{b}	8×10^{c}	$1.0 \times 10^{2\,a}$	1.4×10^{2}	1.1×10^{2}	
0.5 C + 0.1 L	ND	ND^{c}	ND^{e}	ND	1×10^{e}	6×10^{ab}	$1.0 \times 10^{2\,b}$	Ex 15 daysth	Ex 15 daysth		
1.0 C + 0.1 L	ND	ND^{c}	ND^{e}	ND	ND^{f}	5×10^{ab}	$1.1 \times 10^{2\,b}$	Ex 16 daysth	Ex 16 daysth		
1.5 C + 0.1 L	ND	ND^{c}	ND^{e}	ND	ND^{f}	1×10^{c}	7×10^{d}	9×10^{b}	1.4×10^{2} NS	Ex 18 daysth	

Numbers in the column followed by the same letter are not significant different ($P > 0.05$), NS means non significant
ND means not detected in (1gm/9ml)
EX means expire date

Table 2. Effect of cinnamon (C), potassium sorbate (S), lactic acid (L) or combinations of them on the microbial count of Croissant packed in polypropylene bags and stored at room temperature .

Storage period (days)	Zero time	4		8		12		16		20	
treatments	bacteria, yeast and molds CFU/gm	Bacteria CFU/gm	Yeast and molds CFU/gm	Bacteria CFU/gm	yeast and molds CFU/gm	Bacteria CFU/gm	yeast and molds CFU/gm	Bacteria CFU/gm	yeast and molds CFU/gm	Bacteria CFU/gm	yeast and molds CFU/gm
control	ND	9×10^{a}	$1.0 \times 10^{2\,a}$	Ex 8 daysth							
0.5 C	ND	1×10^{b}	5×10^{b}	7×10^{a}	7×10^{a}	Ex 10 daysth					
1.0 C	ND	ND^{c}	2×10^{c}	5×10^{b}	6×10^{b}	Ex 12daysth					
1.5 C	ND	ND^{c}	1×10^{d}	2×10^{c}	4×10^{c}	5×10^{e}	$1.0 \times 10^{2\,d}$	Ex 16 daysth	Ex 16 daysth		
0.1 S	ND	ND^{c}	1×10^{d}	ND^{d}	2×10^{d}	$1.0 \times 10^{2\,a}$	$1.1 \times 10^{2\,b}$	Ex 14 daysth			
0.1 L	ND	ND^{c}	1×10^{d}	ND^{d}	2×10^{d}	8×10^{b}	$1.2 \times 10^{2\,a}$	Ex 14 daysth			
0.5 C + 0.1S	ND	ND^{c}	ND^{e}	ND^{d}	1×10^{e}	7×10^{c}	$1.1 \times 10^{2\,b}$	Ex 16 daysth	Ex 16 daysth		
1.0 C + 0.1S	ND	ND^{c}	ND^{e}	ND^{d}	ND^{f}	6×10^{d}	9×10^{e}	$1.0 \times 10^{2\,a}$	$1.2 \times 10^{2\,b}$	Ex 17 daysth	
1.5 C + 0.1S	ND	ND^{c}	ND^{e}	ND^{d}	ND^{f}	3×10^{g}	7×10^{g}	9×10^{b}	$1.1 \times 10^{2\,c}$	1.0×10^{2}	$1.3 \times 10^{2\,a}$
0.5 C + 0.1 L	ND	ND^{c}	ND^{e}	ND^{d}	ND^{f}	5×10^{e}	$1.0 \times 10^{2\,d}$	$1.0 \times 10^{2\,a}$	$1.3 \times 10^{2\,a}$	Ex 17 daysth	Ex 17 daysth
1.0 C + 0.1 L	ND	ND^{c}	ND^{e}	ND^{d}	ND^{f}	4×10^{f}	8×10^{f}	8×10^{c}	$1.2 \times 10^{2\,b}$	Ex 18 daysth	Ex 18 daysth
1.5 C + 0.1 L	ND	ND^{c}	ND^{e}	ND^{d}	ND^{f}	2×10^{h}	6×10^{h}	7×10^{d}	$1.0 \times 10^{2\,d}$	1.0×10^{2}	1.1×10^{2}
										NS	

Numbers in the column followed by the same letter are not significant different ($P > 0.05$), NS means non significant
ND means not detected in (1gm/9ml)
EX means expire date

Table 3. Effect of cinnamon (C), potassium sorbate (S), lactic acid (L) or combinations of them on the microbial count of Croissant packed in polyethylene bags and stored at (10° C ± 1).

Storage period (days)	Zero time	5		10		20		30		40		50		60	
	bacteria, yeast and molds	Bacteria	Yeast and molds	Bacteria	yeast	Bacteria	yeast	Bacteria	yeast	Bacteria	yeast	Bacteria	yeast	Bacteria	yeast
treatments	CFU/gm	CFU/gm	CFU/gm	CFU/gm	CFU/gm	CFU/gm	CFU/gm	CFU/gm	CFU/gm	CFU/gm	CFU/gm	CFU/gm	CFU/gm	CFU/gm	CFU/gm
control	ND	ND	ND	ND	1×10^{a}	4×10	7×10	6×10^{a}	$1.0 \times 10^{2\,a}$	9×10^{a}	$1.4 \times 10^{2\,a}$	EX42days			
0.5 C	ND	ND	ND	ND	ND[b]	ND[b]	ND[b]	1×10^{c}	2×10^{b}	2×10^{c}	3×10^{b}	8×10^{a}	9×10^{a}	$1.1 \times 10^{2\,a}$	1.2×10^{2}
1.0 C	ND	ND	ND	ND	ND[b]	ND[b]	ND[b]	ND[d]	ND[c]	1×10^{d}	ND[c]	6×10^{b}	8×10^{b}	9×10^{c}	1.0×10^{2}
1.5 C	ND	ND	ND	ND	ND[b]	ND[b]	ND[b]	ND[d]	ND[c]	ND[e]	ND[c]	2×10^{f}	4×10^{e}	7×10^{e}	9×10^{d}
0.1 S	ND	ND	ND	ND	ND[b]	ND[b]	ND[b]	2×10^{b}	ND[c]	5×10	ND[c]	4×10^{d}	7×10^{c}	8×10^{d}	1.2×10^{2}
0.1 L	ND	ND	ND	ND	ND[b]	ND[b]	ND[b]	ND[d]	ND[c]	ND[e]	ND[c]	3×10^{e}	6×10^{d}	7×10^{e}	1.1×10^{2}
0.5 C + 0.1S	ND	ND	ND	ND	ND[b]	ND[b]	ND[b]	ND[d]	ND[c]	ND[e]	ND[c]	5×10^{c}	6×10^{d}	$1.0 \times 10^{2\,b}$	1.1×10^{2}
1.0 C + 0.1S	ND	ND	ND	ND	ND[b]	ND[b]	ND[b]	ND[d]	ND[c]	ND[e]	ND[c]	4×10^{d}	7×10^{c}	8×10^{d}	1.0×10^{2}
1.5 C + 0.1S	ND	ND	ND	ND	ND[b]	ND[b]	ND[b]	ND[d]	ND[c]	ND[e]	ND[c]	3×10^{e}	3×10^{f}	5×10^{g}	6×10^{f}
0.5 C + 0.1 L	ND	ND	ND	ND	ND[b]	ND[b]	ND[b]	ND[d]	ND[c]	ND[e]	ND[c]	3×10^{e}	4×10^{e}	7×10^{e}	9×10^{d}
1.0 C + 0.1 L	ND	ND	ND	ND	ND[b]	ND[b]	ND[b]	ND[d]	ND[c]	ND[e]	ND[c]	2×10^{f}	3×10^{f}	6×10^{f}	8×10^{e}
1.5 C + 0.1 L	ND	ND	ND	ND	ND[b]	ND[b]	ND[b]	ND[d]	ND[c]	ND[e]	ND[c]	ND[g]	ND[g]	5×10^{g}	6×10^{f}

Numbers in the column followed by the same letter are not significant different ($P > 0.05$).
ND means not detected in (1gm/9ml)
EX means expire date

Table 4. Effect of cinnamon (C), potassium sorbate (S), lactic acid (L) or combinations of them on the microbial count of Croissant packed in polypropylene bags and stored at (10° C ± 1).

t Storage period (days) / treatments	Zero time bacteria, yeast and molds CFU/gm	5		10		20		30		40		50		60	
		Bacteria CFU/gm	Yeast CFU/gm	Bacteria CFU/gm	yeast CFU/gm	Bacteria CFU/gm	yeast CFU/gm	Bacteria CFU/gm	yeast CFU/gm	Bacteria CFU/gm	yeast CFU/gm	Bacteria CFU/gm	yeast CFU/gm	Bacteria CFU/gm	yeast CFU/gm
control	ND	ND	ND	1×10^{a}	3×10^{a}	2×10^{a}	7×10^{a}	6×10^{a}	$1.0 \times 10^{2\,a}$	$1.3 \times 10^{2\,a}$	$1.6 \times 10^{2\,a}$	EX45			
0.5 C	ND	ND	ND	ND^{b}	ND^{b}	1×10^{b}	1×10^{b}	2×10^{b}	3×10^{b}	7×10^{b}	5×10^{c}	4×10^{d}	6×10^{a}	8×10^{a}	$1.1 \times 10^{2\,a}$
1.0 C	ND	ND	ND	ND^{b}	ND^{b}	ND^{c}	ND^{c}	ND^{c}	ND^{c}	3×10^{c}	1×10^{e}	5×10^{c}	4×10^{b}	7×10^{b}	$1.0 \times 10^{2\,b}$
1.5 C	ND	ND	ND	ND^{b}	ND^{b}	ND^{c}	ND^{c}	ND^{c}	ND^{c}	ND^{d}	1×10^{e}	1×10^{f}	1×10^{d}	6×10^{c}	9×10^{c}
0.1 S	ND	ND	ND	ND^{b}	ND^{b}	ND^{c}	ND^{c}	ND^{c}	3×10^{b}	ND^{d}	6×10^{b}	7×10^{a}	3×10^{c}	8×10^{a}	1.0×10^{2}
0.1 L	ND	ND	ND	ND^{b}	ND^{b}	ND^{c}	ND^{c}	ND^{c}	ND^{c}	ND^{d}	2×10^{d}	6×10^{b}	4×10^{b}	7×10^{b}	9×10^{c}
0.5 C + 0.1S	ND	ND	ND	ND^{b}	ND^{b}	ND^{c}	ND^{c}	ND^{c}	ND^{c}	ND^{d}	2×10^{d}	4×10^{d}	4×10^{b}	8×10^{a}	$1.1 \times 10^{2\,a}$
1.0 C + 0.1S	ND	ND	ND	ND^{b}	ND^{b}	ND^{c}	ND^{c}	ND^{c}	ND^{c}	ND^{d}	1×10^{e}	3×10^{e}	1×10^{d}	7×10^{b}	$1.0 \times 10^{2\,b}$
1.5 C + 0.1S	ND	ND	ND	ND^{b}	ND^{b}	ND^{c}	ND^{c}	ND^{c}	ND^{c}	ND^{d}	ND^{f}	ND^{g}	1×10^{d}	3×10^{e}	4×10^{g}
0.5 C + 0.1 L	ND	ND	ND	ND^{b}	ND^{b}	ND^{c}	ND^{c}	ND^{c}	ND^{c}	ND^{d}	ND^{f}	ND^{g}	ND^{e}	6×10^{c}	8×10^{d}
1.0 C + 0.1 L	ND	ND	ND	ND^{b}	ND^{b}	ND^{c}	ND^{c}	ND^{c}	ND^{c}	ND^{d}	ND^{f}	ND^{g}	ND^{e}	6×10^{c}	7×10^{e}
1.5 C + 0.1 L	ND	ND	ND	ND^{b}	ND^{b}	ND^{c}	ND^{c}	ND^{c}	ND^{c}	ND^{d}	ND^{f}	ND^{g}	ND^{e}	4×10^{d}	6×10^{f}

Numbers in the column followed by the same letter are not significant different ($P > 0.05$).
ND means not detected in (1gm/9ml)
EX means expire date

Table 5. changes in peroxide values in croissant pastries contains different levels of cinnamon(C), potassium sorbate (S), lactic acid (L) or combinations of them packed in polyethylene or polypropylene bags and stored at room temperature .

Storage Period (Day) / treatments	3		5		7		9		11	
	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene
control	2.12 ^{a}	1.84 ^{a}	3.86 ^{a}	3.42 ^{a}	Ex 6 daysth	4.72 ^{a}	Ex 8 daysth			
0.5 C	1.81 ^{bc}	1.60 ^{bc}	2.92 ^{b}	2.91 ^{c}	3.41 ^{b}	3.20 ^{c}	Ex 9 daysth	3.94 ^{c}		Ex 10 th
1.0 C	1.62 ^{de}	1.49 ^{cd}	2.73 ^{cd}	2.52 ^{d}	3.32 ^{b}	3.14 ^{cd}	3.81 ^{b}	3.72 ^{e}	Ex 11 th	4.42 ^{e}
1.5 C	1.59 ^{e}	1.47 ^{cd}	2.01 ^{f}	1.89 ^{f}	2.86 ^{d}	2.74 ^{fg}	3.43 ^{d}	3.43 ^{g}	4.92 ^{b}	4.76 ^{d}
0.1 S	1.96 ^{b}	1.87 ^{a}	3.84 ^{a}	3.45 ^{a}	4.49 ^{a}	4.38 ^{b}	5.94 ^{a}	5.31 ^{b}	6.36 ^{a}	6.55 ^{b}
0.1 L	1.93 ^{b}	1.85 ^{a}	3.80 ^{a}	3.56 ^{a}	4.51 ^{a}	4.52 ^{ab}	6.03 ^{a}	5.92 ^{a}	6.56 ^{a}	6.72 ^{a}
0.5 C + 0.1S	1.76 ^{cd}	1.57 ^{bcd}	2.81 ^{bc}	2.80 ^{c}	3.32 ^{b}	3.10 ^{cde}	3.69 ^{bc}	3.71 ^{e}	4.25 ^{c}	4.01 ^{f}
1.0 C + 0.1S	1.52 ^{ef}	1.43 ^{d}	2.41 ^{e}	2.30 ^{e}	3.17 ^{c}	2.94 ^{def}	3.45 ^{d}	3.32 ^{h}	4.00 ^{d}	3.82 ^{g}
1.5 C + 0.1S	1.41 ^{f}	1.42 ^{d}	1.97 ^{f}	1.86 ^{f}	2.80 ^{de}	2.56 ^{g}	3.19 ^{e}	3.06 ^{i}	3.62 ^{e}	3.54 ^{h}
0.5 C + 0.1 L	1.88 ^{bc}	1.72 ^{ab}	2.88 ^{bc}	2.87 ^{c}	3.29 ^{b}	3.12 ^{cd}	3.61 ^{c}	3.54 ^{f}	4.91 ^{b}	5.01 ^{c}
1.0 C + 0.1 L	1.64 ^{de}	1.62 ^{bc}	2.61 ^{d}	2.59 ^{d}	3.14 ^{c}	2.90 ^{ef}	3.12 ^{e}	3.10 ^{i}	4.16 ^{cd}	4.13 ^{f}
1.5 C + 0.1 L	1.57 ^{e}	1.62 ^{bc}	2.00 ^{f}	2.15 ^{b}	2.73 ^{e}	2.61 ^{g}	2.81 ^{b}	3.83 ^{d}	3.54 ^{e}	3.62 ^{h}

Continued Table (5)

Storage Period (Day) / treatments	13		15		17		19		21	
	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene
control	Ex 6 daysth	Ex 8 day								
0.5 C	Ex 9 daysth	Ex 10 daysth								
1.0 C	Ex 11th	Ex 12th								
1.5 C	4.95^{a}	4.82^{c}	Ex 15 daysth	5.02^{abc}		Ex 16 daysth				
0.1 S	Ex 13 daysth	6.59^{a}		Ex 14 daysth						
0.1 L	Ex 13 daysth	6.73^{a}		Ex 14 daysth						
0.5 C + 0.1S	4.39^{b}	4.19^{d}	Ex 14 daysth	5.29^{a}		Ex 16 daysth				
1.0 C + 0.1S	4.16^{bc}	3.92^{e}	5.19^{a}	4.21^{cd}	Ex 16 daysth	Ex 17th				
1.5 C + 0.1S	3.82^{c}	3.61^{f}	4.13^{c}	3.92^{d}	4.16^{a}	4.16^{a}	6.92	6.64^{a}	Ex 20th	6.65
0.5 C + 0.1 L	5.07^{a}	5.09^{b}	Ex 15 daysth	5.16^{ab}		Ex 17 daysth				
1.0 C + 0.1 L	4.21^{bc}	4.14^{d}	5.29^{a}	4.19^{bcd}	Ex 16 daysth	4.24^{a}		Ex 18 daysth		
1.5 C + 0.1 L	3.76^{d}	3.71^{ef}	4.07^{b}	4.00^{d}	4.83^{a}	4.03^{a}	Ex 18 daysth	4.19^{b}		Ex 21 daysth

Numbers in the column followed by the same letter are not significant different (P > 0.05).
EX means expire date

Table 6. changes in thiobarbituric acid (TBA) absorbance values in croissant pastries contains different levels of cinnamon (C), potassium sorbate (S), lactic acid (L) or combinations of them packed in polyethylene or polypropylene bags and stored at room temperature .

Storage Period (Day) / treatments	3		5		7		9		11	
	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene
control	0.02 ^{ab}	0.03 ^{b}	0.19 ^{c}	0.18 ^{bc}	Ex 6th	0.26 ^{bc}		Ex 8th		
0.5 C	0.02 ^{ab}	0.02 ^{bc}	0.19 ^{c}	0.11 ^{e}	0.19 ^{e}	0.26 ^{bc}	Ex 9th 0.36	0.30 ^{de}		Ex 10th 0.40
1.0 C	0.03 ^{a}	0.02 ^{bc}	0.15 ^{d}	0.10 ^{e}	0.18 ^{ef}	0.26 ^{bc}	^{bc}	0.35 ^{bc}	Ex 11th	^{cde}
1.5 C	0.02 ^{ab}	0.01 ^{bc}	0.15 ^{d}	0.12 ^{e}	0.19 ^{e}	0.24 ^{cd}	0.33 ^{cd}	0.31 ^{cd}	0.41 ^{b}	0.36 ^{e}
0.1 S	0.03 ^{a}	0.02 ^{bc}	0.29 ^{a}	0.28 ^{a}	0.32 ^{a}	0.33 ^{a}	0.56 ^{a}	0.52 ^{a}	0.56 ^{a}	0.56 ^{b}
0.1 L	0.02 ^{ab}	0.05 ^{a}	0.26 ^{b}	0.26 ^{a}	0.29 ^{b}	0.30 ^{ab}	0.61 ^{a}	0.51 ^{a}	0.59 ^{a}	0.61 ^{a}
0.5 C + 0.1S	0.02 ^{ab}	0.02 ^{b}	0.21 ^{c}	0.20 ^{b}	0.22 ^{d}	0.21 ^{de}	0.33 ^{cd}	0.31 ^{cd}	0.44 ^{b}	0.43 ^{c}
1.0 C + 0.1S	0.02 ^{ab}	0.04 ^{ab}	0.16 ^{d}	0.15 ^{d}	0.18 ^{ef}	0.20 ^{de}	0.31 ^{cd}	0.31 ^{cd}	0.40 ^{b}	0.38 ^{de}
1.5 C + 0.1S	0.02 ^{ab}	0.03 ^{b}	0.12 ^{e}	0.11 ^{e}	0.14 ^{g}	0.14 ^{f}	0.29 ^{cd}	0.26 ^{e}	0.32 ^{c}	0.30 ^{f}
0.5 C + 0.1 L	0.01 ^{b}	0.01 ^{c}	0.21 ^{c}	0.20 ^{b}	0.26 ^{c}	0.24 ^{cd}	0.41 ^{b}	0.32 ^{bcd}	0.41 ^{b}	0.41 ^{cd}
1.0 C + 0.1 L	0.03 ^{a}	0.02 ^{bc}	0.16 ^{d}	0.16 ^{cd}	0.25 ^{c}	0.24 ^{cd}	0.32 ^{cd}	0.36 ^{b}	0.42 ^{b}	0.39 ^{cde}
1.5 C + 0.1 L	0.03 ^{a}	0.05 ^{a}	0.10 ^{e}	0.11 ^{e}	0.16 ^{fg}	0.17 ^{ef}	0.26 ^{d}	0.32 ^{bcd}	0.42 ^{b}	0.36 ^{e}

Continued Table (6)

Storage Period (Day) / treatments	13		15		17		19		21	
	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene	Poly-ethylene	Poly-propylene
control	Ex 6 daysth	Ex 8 daysth								
0.5 C	Ex 9 daysth	Ex 10 daysth								
1.0 C	Ex 11 daysth	Ex 12 daysth								
1.5 C	0.42^{a}	0.39^{de}	Ex 15 daysth	0.49^{c}		Ex 16 daysth				
0.1 S	Ex 13 daysth	0.57^{b}		Ex 12 daysth						
0.1 L	Ex 13 daysth	0.63^{a}		Ex 12 daysth						
0.5 C + 0.1S	0.45^{a}	0.41^{d}	Ex 14 daysth	0.49^{a}		Ex 16 daysth				
1.0 C + 0.1S	0.45^{a}	0.47^{c}	0.56^{a}	0.45^{b}	Ex 16 daysth	Ex 17 daysth				
1.5 C + 0.1S	0.36^{b}	0.41^{d}	0.42^{b}	0.45^{b}	0.51^{b}	0.45^{b}	0.60	0.55^{a}	Ex 20 daysth	0.59
0.5 C + 0.1 L	0.44^{a}	0.40^{de}	Ex 15 daysth	0.51^{a}		Ex 17 daysth				
1.0 C + 0.1 L	0.42^{a}	0.40^{de}	0.55^{a}	0.50^{a}	Ex 16 daysth	0.52^{a}		Ex 18 daysth		
1.5 C + 0.1 L	0.43^{a}	0.38^{e}	0.50^{ab}	0.43^{bc}	0.59^{a}	0.55^{a}	Ex 18 daysth	0.59^{a}		Ex 21 daysth

Numbers in the column followed by the same letter are not significant different ($P > 0.05$).
EX means expire date

Table 7. changes in peroxide values in croissant pastries contains different levels of cinnamon (C), potassium sorbate (S), lactic acid (L) or combinations of them packed in polyethylene bags and stored at (10° C ± 1).

Storage Period (Day) / treatments	5	10	15	20	25	30	35	40	45	50	55	60
control	2.16 ^{a}	2.51 ^{ab}	2.94 ^{a}	2.94 ^{a}	2.96 ^{b}	2.98 ^{a}	3.09 ^{a}	3.10 ^{a}	EX 42th			
0.5 C	2.10 ^{a}	2.31 ^{bc}	2.72 ^{b}	2.73 ^{b}	2.75 ^{c}	2.80 ^{b}	2.82 ^{b}	2.87 ^{bc}	2.89 ^{c}	3.00 ^{d}	3.20 ^{b}	3.20 ^{c}
1.0 C	2.10 ^{a}	2.15 ^{c}	2.17 ^{c}	2.15 ^{c}	2.17 ^{d}	2.17 ^{c}	2.23 ^{cd}	2.35 ^{c}	2.37 ^{d}	2.39 ^{e}	2.56 ^{c}	2.60 ^{d}
1.5 C	2.10 ^{a}	2.10 ^{cd}	2.11 ^{c}	2.13 ^{c}	2.15 ^{d}	2.16 ^{c}	2.16 ^{d}	2.21 ^{d}	2.31 ^{d}	2.32 ^{b}	2.41 ^{d}	2.43 ^{e}
0.1 S	2.10 ^{a}	2.54 ^{a}	2.96 ^{a}	3.00 ^{a}	3.01 ^{a}	3.09 ^{a}	3.13 ^{a}	3.15 ^{a}	3.19 ^{b}	3.71 ^{a}	3.72 ^{a}	3.73 ^{a}
0.1 L	2.12 ^{a}	2.64 ^{a}	2.73 ^{b}	3.04 ^{a}	3.14 ^{a}	3.12 ^{a}	3.10 ^{a}	3.19 ^{a}	3.21 ^{b}	3.62 ^{a}	3.75 ^{a}	3.81 ^{a}
0.5 C + 0.1S	2.13 ^{a}	2.32 ^{bc}	2.86 ^{a}	2.93 ^{a}	2.95 ^{a}	2.99 ^{a}	3.12 ^{a}	3.13 ^{a}	3.15 ^{b}	3.17 ^{c}	3.72 ^{a}	3.75 ^{a}
1.0 C + 0.1S	2.12 ^{a}	2.17 ^{c}	2.19 ^{c}	2.21	2.21 ^{d}	2.25 ^{c}	2.25 ^{c}	2.39 ^{c}	3.39 ^{a}	2.42 ^{e}	2.69 ^{c}	2.72 ^{d}
1.5 C + 0.1S	2.11 ^{a}	2.15 ^{c}	2.17 ^{c}	2.16 ^{c}	2.18 ^{d}	2.17 ^{c}	2.25 ^{c}	2.25 ^{cd}	2.30 ^{d}	2.34 ^{e}	2.36 ^{d}	2.37 ^{e}
0.5 C + 0.1 L	2.10 ^{a}	2.40 ^{b}	2.61 ^{b}	2.81 ^{b}	2.82 ^{b}	2.91 ^{b}	2.93 ^{b}	3.00 ^{b}	3.16 ^{b}	3.11 ^{c}	3.13 ^{b}	3.16 ^{c}
1.0 C + 0.1 L	2.09 ^{a}	2.17 ^{c}	2.19 ^{c}	2.25 ^{c}	2.29 ^{d}	2.29 ^{c}	2.36 ^{c}	2.39 ^{c}	2.41 ^{d}	3.41 ^{b}	2.65 ^{c}	2.69 ^{d}
1.5 C + 0.1 L	2.08 ^{a}	2.11 ^{cd}	2.13 ^{c}	2.15 ^{c}	2.17 ^{d}	2.17 ^{c}	2.19 ^{d}	2.23 ^{d}	2.36 ^{d}	2.37 ^{e}	2.51 ^{d}	2.62 ^{d}

Numbers in the column followed by the same letter are not significant different (P > 0.05).
EX means expire date

Table 8. changes in peroxide values in croissant pastries contains different levels of cinnamon(C), potassium sorbate (S), lactic acid (L) or combinations of them packed in polypropylene bags and stored at (10º C ± 1).

Storage Period (Day) / treatments	5	10	15	20	25	30	35	40	45	50	55	60
control	2.20 ^{a}	2.61 ^{a}	2.96 ^{a}	2.98 ^{a}	3.01 ^{a}	3.11 ^{a}	3.12 ^{a}	3.14 ^{a}	EX 45 th .			
0.5 C	2.12 ^{a}	2.29 ^{b}	2.68 ^{c}	2.71 ^{c}	2.71 ^{c}	2.82 ^{b}	2.84 ^{b}	2.89 ^{b}	2.92 ^{c}	3.10 ^{b}	3.15 ^{b}	3.16 ^{b}
1.0 C	2.12 ^{a}	2.16 ^{c}	2.18 ^{d}	2.19 ^{d}	2.21 ^{d}	2.23 ^{c}	2.41 ^{c}	2.42 ^{c}	2.46 ^{d}	2.50 ^{c}	2.54 ^{d}	2.54 ^{d}
1.5 C	2.16 ^{a}	2.14 ^{c}	2.15 ^{d}	2.16 ^{d}	2.16 ^{d}	2.19 ^{d}	2.23 ^{d}	2.36 ^{c}	2.36 ^{d}	2.42 ^{d}	2.42 ^{de}	2.45 ^{de}
0.1 S	2.11 ^{a}	2.46 ^{ab}	2.81 ^{b}	3.05 ^{a}	3.13 ^{a}	3.17 ^{a}	3.19 ^{a}	3.19 ^{a}	3.41 ^{a}	3.49 ^{a}	3.68 ^{a}	3.72 ^{a}
0.1 L	2.12 ^{a}	2.51 ^{a}	2.75 ^{b}	3.03 ^{a}	3.06 ^{a}	3.12 ^{a}	3.21 ^{a}	3.22 ^{a}	3.24 ^{b}	3.51 ^{a}	3.71 ^{a}	3.72 ^{a}
0.5 C + 0.1S	2.13 ^{a}	2.27 ^{b}	2.71 ^{b}	2.90 ^{a}	2.93 ^{b}	2.96 ^{b}	3.16 ^{a}	3.17 ^{a}	3.18 ^{b}	3.51 ^{a}	3.62 ^{a}	3.62 ^{a}
1.0 C + 0.1S	2.14 ^{a}	2.19 ^{bc}	2.21 ^{d}	2.22 ^{d}	2.23 ^{d}	2.26 ^{c}	2.27 ^{c}	2.42 ^{c}	2.45 ^{d}	2.62 ^{c}	2.81 ^{c}	2.83 ^{c}
1.5 C + 0.1S	2.10 ^{a}	2.16 ^{c}	2.16 ^{d}	2.18 ^{d}	2.19 ^{d}	2.19 ^{d}	2.21 ^{d}	2.26 ^{d}	2.32 ^{de}	2.36 ^{d}	2.39 ^{e}	2.39 ^{e}
0.5 C + 0.1 L	2.15 ^{a}	2.31 ^{b}	2.60 ^{c}	2.86 ^{b}	2.91 ^{b}	2.94 ^{b}	2.95 ^{b}	3.10 ^{a}	3.15 ^{b}	3.16 ^{b}	3.18 ^{b}	3.19 ^{b}
1.0 C + 0.1 L	2.14 ^{a}	2.16 ^{c}	2.24 ^{d}	2.26 ^{d}	2.28 ^{d}	2.31 ^{c}	2.37 ^{c}	2.39 ^{c}	2.46 ^{d}	2.47 ^{d}	2.54 ^{d}	2.59 ^{d}
1.5 C + 0.1 L	2.14 ^{a}	2.15 ^{c}	2.22 ^{d}	2.24 ^{d}	2.24 ^{d}	2.27 ^{c}	2.28 ^{c}	2.28 ^{d}	2.37 ^{d}	2.40 ^{d}	2.41 ^{de}	2.45 ^{de}

Numbers in the column followed by the same letter are not significant different (P > 0.05).
EX means expire date

Table 9. changes in thiobarbituric acid (TBA) absorbance values in croissant pastries contains different levels of cinnamon(c), potassium sorbate (S), lactic acid (L) or combinations of them packed in polyethylene bags and stored at (10° C ± 1).

Storage Period (Day) / treatments	5	10	15	20	25	30	35	40	45	50	55	60
control	0.03^{a}	0.22^{b}	0.23^{c}	0.26^{b}	0.30^{b}	0.32^{b}	0.36^{b}	0.36^{d}	EX 42th			
0.5 C	0.01^{c}	0.12	0.19^{c}	0.24^{d}	0.29^{c}	0.31^{c}	0.36^{b}	0.37^{c}	0.38^{c}	0.44^{a}	0.44^{a}	0.44^{c}
1.0 C	0.02^{b}	0.17^{e}	0.17^{g}	0.18^{f}	0.26	0.26^{e}	0.26^{g}	0.32^{f}	0.37^{d}	0.39^{d}	0.39^{c}	0.40^{f}
1.5 C	0.01^{c}	0.11^{h}	0.12^{h}	0.13^{g}	0.19	0.25^{f}	0.29^{f}	0.32	0.32^{g}	0.34^{h}	0.35^{h}	0.35^{h}
0.1 S	0.02^{b}	0.14^{g}	0.19^{c}	0.22^{e}	0.27^{d}	0.31^{c}	0.35^{c}	0.38^{b}	0.39^{b}	0.40^{c}	0.40^{d}	0.45^{b}
0.1 L	0.02^{b}	0.11^{h}	0.21^{d}	0.24	0.31^{a}	0.30^{a}	0.39^{a}	0.40^{a}	0.40^{a}	0.40^{c}	0.41^{c}	0.44^{c}
0.5 C + 0.1S	0.01^{c}	0.23^{a}	0.23^{c}	0.24^{d}	0.30^{b}	0.31^{c}	0.32^{d}	0.36^{d}	0.38^{c}	0.38^{e}	0.41^{c}	0.43^{d}
1.0 C + 0.1S	0.02^{b}	0.20^{d}	0.20^{e}	0.24^{d}	0.25	0.29^{d}	0.31^{e}	0.32^{f}	0.32^{g}	0.36^{f}	0.36^{g}	0.36^{g}
1.5 C + 0.1S	0.01^{c}	0.15^{f}	0.20^{e}	0.23	0.27^{d}	0.29^{d}	0.29^{f}	0.31	0.31^{h}	0.32^{i}	0.32^{i}	0.34^{i}
0.5 C + 0.1 L	0.03^{a}	0.21^{c}	0.23^{c}	0.25^{c}	0.26	0.26^{e}	0.32^{d}	0.36^{d}	0.37^{d}	0.40^{c}	0.40^{e}	0.42^{e}
1.0 C + 0.1 L	0.01^{c}	0.22^{b}	0.24^{b}	0.28^{a}	0.29^{c}	0.32^{b}	0.32^{d}	0.34^{e}	0.34^{f}	0.35^{g}	0.35^{h}	0.36^{g}
1.5 C + 0.1 L	0.03^{a}	0.23^{a}	0.26^{a}	0.28^{a}	0.29^{c}	0.31^{c}	0.32^{d}	0.32^{f}	0.35^{e}	0.35^{g}	0.35^{h}	0.35^{h}

Numbers in the column followed by the same letter are not significant different ($P > 0.05$).
EX means expire date

Table 10. changes in thiobarbituric acid (TBA) absorbance values in croissant pastries contains different levels of cinnamon(C), potassium sorbate (S), lactic acid (L) or combinations of them packed in polypropylene bags and stored at (10° C ± 1).

Storage Period (Day) / treatments	5	10	15	20	25	30	35	40	45	50	55	60
control	0.02 [a]	0.13 [c]	0.21 [a]	0.21 [b]	0.30 [a]	0.31 [a]	0.31 [b]	0.42 [a]	EX 45th			
0.5 C	0.02 [a]	0.15 [a]	0.19 [b]	0.22 [a]	0.25 [b]	0.27 [b]	0.33 [a]	0.38 [b]	0.38 [b]	0.40 [b]	0.40 [c]	0.42 [d]
1.0 C	0.02 [a]	0.13 [c]	0.12 [g]	0.19 [c]	0.20 [f]	0.22 [e]	0.25 [h]	0.29 [e]	0.30 [e]	0.30 [g]	0.31 [i]	0.36 [f]
1.5 C	0.02 [a]	0.10 [e]	0.13	0.15 [g]	0.21 [e]	0.21 [f]	0.26 [g]	0.34 [c]	0.35 [c]	0.35 [d]	0.35 [f]	0.35 [g]
0.1 S	0.02 [a]	0.13 [c]	0.14 [e]	0.15 [g]	0.16 [i]	0.22 [e]	0.27 [f]	0.30 [d]	0.31 [d]	0.36 [c]	0.40 [c]	0.46 [a]
0.1 L	0.02 [a]	0.12 [d]	0.13	0.17 [e]	0.22 [d]	0.25 [c]	0.30 [c]	0.34 [c]	0.39 [a]	0.40 [b]	0.42 [b]	0.45 [b]
0.5 C + 0.1S	0.02 [a]	0.12 [d]	0.16 [c]	0.16 [f]	0.17 [h]	0.19 [g]	0.24 [i]	0.24 [h]	0.29 [f]	0.34 [e]	0.36 [e]	0.41 [e]
1.0 C + 0.1S	0.02 [a]	0.10 [e]	0.13 [f]	0.17 [e]	0.19 [g]	0.21 [f]	0.22 [g]	0.23 [i]	0.31 [d]	0.31	0.33 [g]	0.33 [i]
1.5 C + 0.1S	0.02 [a]	0.12 [d]	0.13 [f]	0.15 [g]	0.16 [i]	0.19 [g]	0.24 [i]	0.26 [g]	0.30 [e]	0.31	0.32 [h]	0.32 [g]
0.5 C + 0.1 L	0.01 [b]	0.15 [a]	0.15 [d]	0.18 [d]	0.23 [c]	0.24 [d]	0.28 [e]	0.28 [f]	0.31 [d]	0.34 [e]	0.37 [d]	0.42 [d]
1.0 C + 0.1 L	0.03 [c]	0.14 [b]	0.14 [e]	0.19 [c]	0.19 [g]	0.25 [c]	0.29 [d]	0.30 [d]	0.31 [d]	0.31 [f]		0.31 [j]
1.5 C + 0.1 L	0.03 [c]	0.13 [c]	0.14 [e]	0.16 [f]	0.21 [e]	0.22 [e]	0.26 [g]	0.28 [f]	0.28 [g]	0.30 [g]	0.30 [i]	0.34 [h]

Numbers in the column followed by the same letter are not significant different (P > 0.05).
EX means expire date

REFERENCES

1. A.O.A.C. 2000. Official Methods of Analysis of the Association of Analytical Chemists, 17th. Washington. D.C, U.S.A.
2. Alippi, A. M., J. A. Ringuelet, E. L. Cerimele and C. P. Henning. 1996. Antimicrobial activity of some essential oil against *paenibacillus larvae,* the causal agent of American foulbrood disease. *J. Herbs, Spices Med. Plants, 4,9 – 16.*
3. Bullerman, L. B. 1974. Inhibition of aflatoxin production by cinnamon. *J. Food Sci. 39, 1663-1165.*
4. Ceylan, E., D. Y. C. Fung and J. R. Sabah. 2004. Antimicrobial activity and synergistic effect of cinnamon with sodium benzoate or potassium sorbate in controlling Escherichia coli 0157: H7 in apple juice. *J. Food Sci. , 69, FMS 102-106.*
5. Cochran, W. G. And G. M. Cox. 1992. Experimental Designs, 2nd Ed., Wiley. New York.
6. Farag, R. S., A. Z. M. Badei and G. S. El-Baroty. 1989. Influence of the thyme and clove essential oils on cotton seed oil oxidation. *J. Amer. Oil Chem.. Soc.,66, 800-804.*
7. Huwez, F. U., D. Thirlwell, A. Cockayne, and D. A. A. ALA aldeen. 1998. Mastic gum kills *Helicobacter pylori.* New England *J. Med. 339, 1946.*
8. Koukoutsis, J., J. P., Smith, D. P. Daifas, V. Yayalan, B. Cayoueth, M. Ngadi and W. El – Khoury. 2004. Invitro studies to control the growth of microorganisms of spoilage and safety concern in high – moisture, high – pH bakery products. *J. Food Safety, 24, 211-230.*
9. Miller, K. L. 1993. High-stability oils. *Cereal Foods World.38,478-482*
10. Orthoefer, F. T. and D. S. Cooper. 1996. :Evaluation of used frying oil ,in deep-frying Cheistry,Nutrition and Practical Application,edited by E.G.Perkins and M.D.Erickson,AOAC Pree,Champaiga,1996,PP.285-296.
11. Perkins, E. G. 1988. The analysis of frying fats and oils. *J.Am.Oil Chem.Soc.65,520-525*
12. Ouattara, B., R., Simard, R. Holley, G. J. P. Piette and A. begin. 1997. Antibacterial activity of selected fatty acids and essential oils against six meat spoilage organisms. *Int. J. Food Microbiol. 37, 155-162.*

13. Sidwell, C. G., S. Harold, B. Milaclo and J. H. Mitchell. 1954. The use of thiobarabituric as a measure of fat oxidation.*J. Am. Oil Chem.. Soc. 63, 1363-1367.*

14. Simth, J. P., D. Daifas, P. El-Khoury and I. Tarte. 2002. Food borne illnesses associated with bakery products. *Technical Bulletin, Am. Inst. Baking 24, 1-11.*

15. Sternhagent, L. G. and R. C. Hoseney. 1994. Firming effect in Danish pastry. *Cereal chem.., 71, 560-563.*

16. Topallar, H., Y. Bayrak, and M. J. Isean. 1997. A kinetic study of the antioxidation of sunflower seed oil. *J. Am. Oil Chem. Soc. 74,1323-1327*

17. Ueda, S., H. Yamashita, M. Nakajima, and Y. Kuwabara. 1982. Inhibition of microorganisms by spice extracts and flavoring compounds. *J Jpn Soc Food Sci Technol., 29, 111-116.*

تأثير القرفة مع أو بدون سوربات البوتاسيوم أو حمض اللاكتيك وكذلك مواد التعبئة و درجة حرارة التخزين علي طول فترة صلاحية الكر وسان

أيمن محمد محمد العناني ، هالة محمد زكي محمد

معهد بحوث تكنولوجيا الأغذية – مركز البحوث الزراعية

في هذه الدراسة تم استخدام القرفة – سوربات البوتاسيوم –حمض اللاكتيك أو مخاليطهم كمواد حافظة لمنتج الكروسان حيث تم إضافة القرفة بمعدل ٠،٥ % و١ و١،٥% من وزن الدقيق أو مخلوطة مع١، ٠ % من السوربات البوتاسيوم أو حمض اللاكتيك . أظهرت نتائج هذه الدراسة أن إضافة القرفة بمعدل ١،٥% كان له تأثير فعال كمضاد للميكروبات و الأكسدة و قد أزداد هذا التأثير بإضافة ٠،١ % من سوربات البوتاسيوم أو حمض اللاكتيك. أوضحت النتائج أيضا أن تعبئة الكروسان في أكياس من مادة البولي بر وبيلين كان أكثر حماية للمنتج من تعبئته في أكياس من البولي أيثلين كما أن تخزين المنتج علي درجة حرارة منخفضة (١٠ درجة مئوية) ساهم بدرجة عالية في أطالة فترة حفظ المنتج مقارنة بدرجة حرارة الغرفة.