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ORIGINAL ARTICLE

Effect of active packaging on low-sodium restructured chicken steaks

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Abstract Contributing for a healthier lifestyle, the technology of active and biodegradable packaging with antimicrobial and/or antioxidants compounds and reduced sodium intake have been increasingly applied in meat and meat products. Thus, the objective of this research was to assess the effectiveness of oregano essential oil (OEO) and potassium sorbate incorporated in packaging applied to the restructured chicken steaks with 40 % reduction in sodium chloride in frozen storage for 150 days. The composition of packaging did not influence moisture, crude protein, total lipids, ash, sodium and potassium content as well as pH evaluated on days 0 and 150. Salty taste was the only significant indication in the sensory analysis ($p<0.05$). The use of 1 % and 0.5 % OEO incorporated in packaging reduced rancidity through lipid oxidation and can be regarded as an active antioxidant; the use of oregano or potassium sorbate in active films caused the development delay effect *E. coli*. Thus, the use of active packaging may maintain the product quality.

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Introduction

Currently, researches on biopolymers include polysaccharides, proteins, and their blends are being used to add different additives, such as antimicrobial, antioxidant and flavoring agents the development of active food packaging. The term "active packaging" is used to extend shelf life, maintain or improve quality, as well as active agents that can be added such as organic acids, some plant extracts and their essential oils (Appendini and Hotchkiss 2002; Dainelli et al. 2008; Tharanathan 2003).

In addition, the development of convenient meat products such as restructured chicken steaks along with the changing in consumers based on a healthier lifestyle have promoted sodium and reduced fat, replacement of chemical additives for natural ones and the emerging of new packaging materials, active, intelligent and edible (Burt 2004; Berti et al. 2011; Dainelli et al. 2008; Kerry et al. 2006).

Therefore, sodium content in meat products contributes to important quality, technological properties and food safety, but their consumption is associated to the development of hypertension and consequently cardiovascular disease. The FSA and IOM recommend that the consumption of sodium does not exceed 2.4 g (equivalent to gram of salt/day). The model of the FSA is proposing a campaign for a 40 % reduction in hamburger (Cofrades et al. 2011; Micha et al. 2010; Ruusunen and Puolanne 2005).

In an attempt to reduce the sodium content in meat products, it was suggested to be replaced by potassium chloride (KCl), magnesium chloride ($MgCl_2$), calcium chloride ($CaCl_2$) and their blends (Horita et al. 2011). Among those mentioned above, potassium chloride (KCl) has been the most

investigated and it is an alternative to possess properties similar to NaCl also, generally regarded as being safe.

Advances in packaging and ingredients for meat products is an alternative to consumers demand for natural products or reducing the amount of chemical additives; moreover, its potential of providing quality and safety benefits. One alternative when adding such ingredients into meat products is to add them in packaging. Studies have investigated the action, of potassium sorbate and oregano oil incorporated into films as antioxidant and antimicrobial actives (Bolumar et al. 2011; Camo et al. 2011; Emiroğlu et al. 2010; Flores et al. 2007; Shen et al. 2010; Vásconez et al. 2009; Zinoviadou et al. 2009).

Thus, the aim of this research was to study the antimicrobial and antioxidant effectiveness in the restructured chicken steaks with reduction in sodium chloride content applying biodegradable and active packaging with addition of oregano oil and potassium sorbate.

Material and methods

Film production

Extrusion employing high pressures and temperature was used to develop packaging techniques. The processing was split into two steps: the first stage was the extrusion process; the second stage reprocessed the pellets, which were extruded again for the film formation.

The films were produced in the Laboratory of Food Science and Technology Department at the State University of Londrina. Starch (Indemil, Brazil) and glycerol (Synth P.A) to obtain thermoplastic starch (TPS), poly (butylene adipate-co-terephthalate) (PBAT – BASF, Germany) under the trade name Ecoflex® S BX 7025, oregano oil and/or potassium sorbate were homogenized at the first stage, these mixtures were then extruded in order to obtain pellets by using twin screw extruder (model D-20 series 9002.001, BGM, São Paulo, Brazil) with a screw diameter of D=20 mm, 68 cm length, five heating zones (Z1=90ºC, Z2=120ºC, Z3=120ºC, Z4=120ºC, Z5=120ºC) at 100 rpm, and die with five holes the 2 mm diameter.

Thereafter, the films were obtained through blow extrusion using a mono screw extruder (model EL-25, BGM, São Paulo, Brazil) with a D=25 mm diameter screw and a 28 D length screw, four heating zones with a temperature profile of 120/120/120/115ºC and a 35 rpm speed screw, with two 3 mm diameter. The extruder was fed manually with the pellets (blends) and the film formed through the blowing technique (film balloons) by injecting compressed air inside and outside the balloon, both polyurethane rollers speed and coil were held constant.

Four different types of packaging were prepared by replacing partial starch for oregano oil (OEO), potassium sorbate or a mixture of both, their composition is shown in Table 1.

Table 1 Composition (%) of biodegradable and active packaging

Component	Control	F1	F2	F3
Ecoflex	40	40	40	40
Glycerol	13	13	13	13
Starch	47	46	42	44
Oregano oil	–	1	–	0.5
Potassium sorbate	–	–	5	2.5

Glycerol addition was the strategy selected for most of the research in order to reduce the water vapor transmission rate. Each film obtained was manually cut in a 12 cm square with sterile scissor and then sealed (sealing model R. Baião Industrial, BR).

Restructured chicken steaks processing

The restructured chicken steaks were processed in the Laboratory of Meat, at Department of Food Engineering, State University of Maringa, and prepared using 62.5 % chicken breast obtained from an industrial supplier (Frangos Canção, PR, Brazil), 20 % pork fat, 10 % water, 5 % isolated soy protein, with 0.6 % sodium chloride and 0.6 % potassium chloride (in total 1.2 % salts), 0.4 % phosphate, 0.25 % dextrose, 0.05 % white pepper, 0.10 % garlic powder, and 0.5 % condiment prepared burger.

The chicken meat and fat were cut into pieces of nearly 5x5 cm by using a knife, ground twice together using an electric meat grinder (C.A.F Standard, BR) through 5 mm disks, and hand mixed for 2 min with other ingredients according to GMP (Good Manufacturing Practices).

Ground chicken mixture was weighed into 80±0.5 g portions and became individual chicken steaks through manual molder cylinder (10 cm diameter) and separate in four treatments. The treatments consisted of 1) sample packaging with control films (C); 2) sample packaging with 1 % OEO added films (F1); 3) sample packaging with 5 % potassium sorbate added films (F2); and 4) sample packaging with 0.5 % OEO and 2.5 % potassium sorbate added films (F3), all treatments were frozen and storage at 150 days.

Proximate analysis, sodium and potassium content and pH

The moisture, protein, ash, sodium and potassium contents were determined according to the AOAC (1998) method. The fat content was quantified as described by Bligh and Dyer (1959). All tests were performed in triplicate on days 0 and 150. The pH was determined by homogenizing 10 g of each sample with distilled water in a 1:10 ratio in triplicate. The homogenate content was subjected to meter electrodes (Digimed) for five minutes, while the pH readings were performed on days 0 and 150.

TBARS analysis

Lipid oxidation was determined using the thiobarbituric acid reactive substance test (TBARS) as described by Raharjo et al. (1992) and measurements were performed in triplicate for each treatment on days 0, 30, 60, 90, 120 and 150. TBARS values are reported as milligrams of malonaldehyde per kg of meat.

Microbiology analysis

On days 0, 30, 60, 90, 120 and 150, triplicate packages from each treatment were aseptically opened, crushed and a 25 g-portion was homogenized with 225 mL peptone water for 1 min to carry out the initial dilution (10^{-1}).

Appropriated serial dilutions (until 10^{-6}) were spread plated on Plate Count Agar (PCA; Merck, Germany) for total viable counts (TVC), Violet Red Bile Agar (VBR, Merck) for total coliforms and *Escherichia coli*, Baird Parker agar base and egg youlk tellurite emulsion (BPA, Merck) for *Staphylococcus spp.* counts, and with lyophilized rabbit plasma (Newprov) for the coagulate test, followed by incubation at 7ºC for ten days for TVC, at 37ºC for 48 h for coliforms and *Staphylococcus spp.*

The methodology used to research *Salmonella spp.* was according (FDA-USA, 1998). Rappaport Vassiliadis Soya Broth (RVS broth, Merck, Germany) received incubation at 42ºC and Selenite cystine (SC broth, Merck) at 35ºC for 24 h, after this period, plates in lysine decarboxylase broth (Merck) and Hektoen enteric (HE agar, Merck) were incubated at 35ºC for 24 h. For preliminary confirmation of colonies triple sugar iron agar (TSI, Merck) and lysine iron agar (LIA, Merck) performer and incubated at 35ºC for 24 h and for biochemical tests for final confirmation mini kit were used to Enterobacteria containing ten biochemical tests (Newprov). Bacterial counts were expressed as $\log_{10}$ colony forming units (CFU)/g sample.

Texture

The samples were grilled on hot plate (grill type) at 180ºC until internal temperature of 72ºC AMSA (1995) monitored with thermocouples inserted approximately the geometric center of chicken burger, then chilled at the temperature of 4 °C.

Shear force testing was performed with a TA-xT2i texture analyzer (Stable Micro Systems Ltd.) with cell Warner Bratzler, with a speed of 10 mm/s and using 25 mm depth (Wheeler et al. 1996). The results were expressed as the maximum force in kg required for shearing the samples. For this test, the samples were sliced (1 cm thick x 4–5 cm in length x 2 cm width), resulting in three samples of each chicken steaks in triplicate for each treatment.

Sensory analysis

The sensory analysis protocol for the restructured chicken steaks was previously approved by the Committee of Ethics in Research, at the State University of Maringa, PR, Brazil, under protocol CAAE 01927712.5.0000.0104. The sensory analysis was conducted by 60 panelists recruited among students on campus consumers of chicken burger, 19–35 years old after 15 days storage. The acceptance test used a scale to measure consumers' reaction (like/dislike) concerning attributes of appearance, flavor, salty taste, texture and overall liking.

The samples were grilled on hot plate (grill type) at 180ºC, up to internal temperature of 72ºC, diced 2 x 2 cm surrounded by aluminum foil and kept warm in an electric oven, presented in random blocks in a sequential monadic using a 9-hedonic scale anchored in its highest and lowest evaluations 1 – completely disliked and 9– completely liked (Macfie et al. 1989). The tests were conducted at the Sensory Analysis Laboratory of the Department of Food Engineering in individual booths with daylight-like lighting.

Statistical analysis

Data were evaluated through variance analysis (ANOVA). Least squares differences were used to compare mean values for treatments and Tukey's HSD test was used to identify significant differences in formulation and storage periods with a confidence level of 5 % using the version 9.1 of SAS statistical package program (SAS, 2004).

Results and discussion

Proximate analysis, sodium and potassium content and pH

The composition of packaging did not influence of moisture, crude protein, total lipids, ash, sodium and potassium content and pH evaluated on days 0 and 150, as the data presented on Table 2.

The result expected for day 0 due to the base (ground chicken mixture) was the same for all different active packaging, and after 150 days of freezing storage it did not alter significantly the physico-chemical evaluation. There was no mass loss over the 150 days of storage under freezing, important result in the case of frozen meat for not having moisture loss occurred during this period.

The salt content usually added in this meat product is 2 % (NaCl), its main functions are to preserve and extract myofibrillar protein which will assist in linking ground meat to keep the product shape after cooking and flavoring (Ruusunen and Puolanne 2005).

In this study, the level of salt added was 1.2 % (reduction of 40 %) and from this total 0.6 % sodium chloride and 0.6 %

Table 2 Proximate analysis, sodium and potassium content and pH

	Moisture (%)	Crude Protein (%)	Total Lipids (%)	Ash (%)	Sodium (mg/100 g)	Potassium (mg/100 g)	pH
0 day							
C	63.52 (0.42)^{aA}	20.33 (0.16) ^{aA}	12.75 (0.24) ^{aA}	3.40 (0.11) ^{aA}	341(0.57) ^{aA}	331(0.31) ^{aA}	6.12(0.11) ^{aA}
F1	62.87 (0.31) ^{aA}	20.46 (0.24) ^{aA}	13.42 (0.39) ^{aA}	3.25 (0.06) ^{aA}	335(0.45) ^{aA}	342(0.43) ^{aA}	6.14(0.06) ^{aA}
F2	60.73 (0.68) ^{aA}	21.44 (0.82) ^{aA}	14.40 (0.15) ^{aA}	3.43 (0.02) ^{aA}	331(0.32) ^{aA}	337(0.54) ^{aA}	6.15(0.03) ^{aA}
F3	62.20 (0.29) ^{aA}	20.72 (0.26) ^{aA}	13.68 (0.32) ^{aA}	3.40 (0.10) ^{aA}	339(0.48) ^{aA}	336(0.35) ^{aA}	6.13(0.15) ^{aA}
150 day							
C	61.85 (0.53) ^{aA}	22.82 (0.80) ^{aA}	12.12 (0.26) ^{aA}	3.21 (0.61) ^{aA}	338(0.42) ^{aA}	335(0.38) ^{aA}	6.16(0.08) ^{aA}
F1	61.08 (0.75) ^{aA}	23.48 (0.51)^{aA}	12.25 (0.35) ^{aA}	3.19 (0.69) ^{aA}	332(0.54) ^{aA}	336(0.31) ^{aA}	6.15(0.13) ^{aA}
F2	60.20 (0.35) ^{aA}	23.33 (0.67) ^{aA}	13.16 (0.48) ^{aA}	3.31 (0.50) ^{aA}	328(0.44) ^{aA}	330(0.41) ^{aA}	6.14(0.11) ^{aA}
F3	61.64 (0.71) ^{aA}	22.67 (0.70) ^{aA}	12.37 (0.46) ^{aA}	3.32 (0.18) ^{aA}	336(0.28) ^{aA}	331(0.41) ^{aA}	6.12(0.06) ^{aA}

Values expressed as mean (standard deviation)

^{a,b} Means in the columns with the same letters did not differ significantly from samples, and,

^{A,B} Means in the columns with the same letters did not differ significantly from days at $p<0.05$ (Tukey's test)

C – control; F1 – 1 % oregano oil; F2 – 5 % potassium sorbate; F3 – 0,5 % oregano oil and 2,5 % potassium sorbate

potassium chloride, corresponding to 330 mg sodium and potassium/100 g free of additives in the product mass, making it important to monitor the products shelf life, mainly concerning microbiological quality.

Lipid oxidation

Chicken meat contains high levels of unsaturated fat considered highly susceptive to oxidation, the use of antioxidants in the processing of chicken products currently in active packaging has been researched in order to control these lipid oxidation products (Abreu et al. 2012; Bolumar et al. 2011; Kanner 1994).

The substitution of synthetic additives by natural antioxidants, especially plant extract and essential oils from herbs such oregano, rosemary, is one viable alternative to consumers seeking healthier products and better quality of life (Contini et al. 2011; Dainelli et al. 2008; López-de-Dicastillo et al. 2012). Anthony et al. (2012) evaluated antioxidant actives from 423 essential oils using DPPH methodology and obtained that botanical families Lamiaceae, comprising oregano carries the most active antioxidant essential oils as well as seven other families (Frankincensea, Lauraceae, Leguminosae, Magnoliaceae, Myrtaceae, Scrophulariaceae, and Zingiberraceae).

Lipid oxidation was evaluated through the levels of TBARS developed during freezing storage up to day 150 (Table 3). Soon after processing (time zero), there was no difference among the formulations ($p<0.05$), as expected active packaging does not bear any effect on products, which remained so until the day 60 evaluation, after this period values significantly increased. Control film had the highest TBARS values, F1 and F3 the lowest ones (but did not differ significantly) and intermediate values ($p<0.05$) for F2. The lowest level for mg malonaldehyde in formulations F1 and F3 is because the oregano essential incorporated in packaging can be considered as an active antioxidant. According to Quintavalla and Vicini (2002) the use of active packaging can prevent moisture loss during storage of fresh and frozen meats and consequently reduce rancidity oxidative.

In a study to evaluate beef steaks display life, when packaged with active film with (0.5, 1, 2, 4 %) an oregano extract incorporated as antioxidant, the use of active packaged significantly enhanced oxidative stability and 1 % oregano shown to be effective as an antioxidant ($p<0.05$) from day 14 to day 23 at 1 °C, without affecting the product sensory quality (Camo et al. 2011). Another study on sardine at 5 °C in edible films incorporated oregano or rosemary essential oils and observed reduced lipid oxidation (Gómez-Estaca et al. 2010).

Microbiology analysis

The manufacture of chicken steaks entails a great deal of handling, low sodium content and hence high susceptibility to contamination, which must therefore be monitored (Table 4). In all samples *Salmonella spp.* was absent in 25 g on both day 0 and 150, and *Staphylococcus spp.* coagulate positive was negative for all evaluation days.

The results for initial coliforms counts for all chicken burger (2.29–2.48 log CFU/g) increased through time up to freezing storage day 60, after this period until storage ended there was a decreasing (Table 4). When evaluating all 150 days, no significant difference in coliforms was found in general, but the evaluation between treatments and the use of oregano essential oil (1 %) resulted in the lowest means when compared to others treatments ($p<0.05$).

Table 3 TBARS values on restructured chicken steaks packaged with active films

Sample	mg malonaldeyde/Kg sample					
	0	30	60	90	120	150
C	0.095 (0.12)^{aC}	0.124 (0.06)^{aC}	0.144 (0.13)^{aC}	0.271 (0.06)^{aB}	0.295 (0.09)^{aB}	0.326 (0.06)^{aA}
F1	0.091 (0.09)^{aB}	0.177 (0.11)^{aA}	0.137 (0.08)^{aA}	0.135 (0.04)^{cA}	0.143 (0.11)^{cA}	0.142 (0.09)^{cA}
F2	0.095 (0.10)^{aB}	0.123 (0.08)^{aB}	0.143 (0.11)^{aB}	0.174 (0.08)^{bA}	0.189 (0.07)^{bA}	0.194 (0.08)^{bA}
F3	0.091 (0.08)^{aA}	0.121 (0.03)^{aA}	0.141 (0.12)^{aA}	0.145 (0.09)^{cA}	0.132 (0.08)^{cA}	0.148 (0.11)^{cA}

Values expressed as mean (standard deviation)

^{a,b,c} Means in the columns with the same letters did not differ significantly from samples, and,

^{A,B} Means in the lines with the same letters did not differ significantly from days at $p<0.05$ (Tukey's test)

C – control; F1 – 1 % oregano oil; F2 – 5 % potassium sorbate; F3 – 0,5 % oregano oil and 2,5 % potassium sorbate

The initial count of *E. coli* were significant ($p<0.05$) and the active ingredients added on packaging showed the lower grades compared to control, after 30 days this microorganism was not detected in treatment with OE and potassium sorbate, and in control had reduced the count. Such result demonstrated that the use of oregano or potassium sorbate in active films resulted in a delay effect for *E. coli* development. Similarly, Emiroğlu et al. (2010) incorporated edible films with thyme and oregano essential oils (1–5 %) on beef patties obtained reductions ($p<0.05$) in coliforms and *Pseudomonas* spp. counts at minimum concentration (1 %) applied into the films formulations, similarly result also found by Oussalah et al. (2006) when added 1 % oregano oil applied into milk protein based films for the muscle preservation, and by Zinoviadou et al. (2009) who incorporated 0.5, 1.0 and 1.5 % of oregano oil into films of fresh beef resulting in total flora (TVC) and pseudomonads being reduced. Applied oregano, rosemary and garlic essential oils 1–4 % in edible films Seydim and Sarikus (2006) revealed that the use of 2 % oregano essential oils was the most effective factor against *Staphilococcus aureus, Salmonella enteritidis, Listeria monocytogenes, Escherichia coli* O157:H7 and *Lactobacillus plantarum*.

This positive result of active packaging with OEO against *E. coli* may be explained because the essential oil of oregano contains phenolic compounds as carvacrol, thymol, γ-terpinene and p-cymene that, which are active compounds

Table 4 Microbiological counts (log CFU/g) during freezing storage of restructured chicken steaks

		Days of freezing storage					
		0	30	60	90	120	150
Microorganisms	Sample	Cell counts (log CFU/g)					
Total viable	C	6.26^{aA}	5.97^{aB}	5.72^{aBC}	5.61^{aC}	5.60^{aC}	5.72^{aBC}
Counts (7ºC)	F1	6.24^{abA}	4.45^{cD}	5.19^{bB}	4.78^{cC}	5.18^{cB}	5.33^{bcB}
	F2	6.00^{bA}	5.41^{bB}	5.25^{bB}	5.25^{bB}	5.23^{bcB}	5.25^{cB}
	F3	6.13^{abA}	5.52^{bB}	5.54^{aB}	5.40^{abB}	5.44^{abB}	5.53^{abB}
Total Coliforms	C	2.48^{aAB}	2.37^{aB}	2.80^{aA}	2.72^{aAB}	2.49^{aAB}	2.45^{aAB}
	F1	2.30^{aA}	1.39^{bB}	2.47^{bA}	2.16^{bcA}	2.21^{bA}	2.13^{bA}
	F2	2.29^{aAB}	1.35^{bC}	2.51^{abA}	1.98^{cB}	2.35^{abA}	2.24^{abAB}
	F3	2.37^{aAB}	2.12^{aB}	2.74^{abA}	2.46^{abAB}	2.44^{aAB}	2.32^{aB}
E. coli	C	2.36^{aB}	1.30^{B}	1.60^{A}	1.59^{A}	1.45^{AB}	1.24^{B}
	F1	1.93^{b}	ND	ND	ND	ND	ND
	F2	1.94^{b}	ND	ND	ND	ND	ND
	F3	1.39^{c}	ND	ND	ND	ND	ND

^{a,b,c} Means in the columns with the same letters did not differ significantly from samples, and,

^{A,B} Means in the lines with the same letters did not differ significantly from days at $p<0.05$ (Tukey's test)

ND not detected

C – control; F1 – 1 % oregano oil; F2 – 5 % potassium sorbate; F3 – 0,5 % oregano oil and 2,5 % potassium sorbate

and acts directly on the membrane of microorganisms through disintegrating and increasing membrane permeability (Burt 2004; Burt et al. 2005; Moreira et al. 2005).

Furthermore, through the use of OEO in this study we were able to evaluate the effect of potassium sorbate (KS) as a demonstration of antimicrobial activity against several microorganisms, as revealed by previous studies (Flores et al. 2007; Shen et al. 2010; Vásconez et al. 2009). The use of KS incorporated in films containing starch can reduce hydrogen bonds and alter gas permeability increasing the antimicrobial potential (Kristo et al. 2008; Shen et al. 2010). The use of KS in tapioca starch edible films and in films obtained through extrusion evaluated using *Z. bailli* as indicator, revealed extender lag phase and decreased yeast growth rate (Flores et al. 2007; Flores et al. 2010).

Texture and sensory analysis

Shear force evaluation showed no difference for treatments as ($p>0.05$) the expected result verified, once we started from the same ground chicken mixture, with means between 39.23 and 41.19 N.

The use of active compounds as antioxidant and/or antimicrobial in meat and meat products can cause effects on sensory quality. Some authors have also reported that the higher level of essential oils used the greatest amount of antimicrobial and antioxidant contents, however it causes opposite effects on sensory quality, mainly regarding flavor (Camo et al. 2011).

In sensory analysis the attributes of appearance, flavor, texture and overall liking were not significant ($p>0.05$) among treatments presenting averages of 7.0 (liked regularly), and significantly for salty taste ($p<0.05$), F1 the lowest means (6.2 - like slightly), different from others treatments (7.1–7.4), the results as show Table 5. The panelists explained the lowest average concerning the treatment F1 due to a more salty quality indicated in the comments at the bottom of evaluation questionnaire, however the salt level used was the same in all formulations.

Table 5 Result of sensory evaluation on restructured chicken steaks packaged with active films.

	Appearance	Flavor	Salty taste	Texture	Overall liking
C	7.1[a]	6.9[a]	7.1[a]	7.3[a]	7.3[a]
F1	6.9[a]	7.1[a]	6.2[b]	7.2[a]	7.1[a]
F2	7.2[a]	7.0[a]	7.4[a]	7.5[a]	7.3[a]
F3	7.1[a]	7.3[a]	7.6[a]	7.5[a]	7.4[a]

Values expressed as mean (standard deviation)

[a,b] Means in the columns with the same letters did not differ significantly from samples at $p<0.05$ (Tukey's test)

C – control; F1 – 1 % oregano oil; F2 – 5 % potassium sorbate; F3 – 0,5 % oregano oil and 2,5 % potassium sorbate

A similar study with 1–2 % OEO incorporated in chitosan film evaluated the consumer linking with 48 panelists through a 9-point hedonic scale on bologna slice; as results the addition of the oregano may negatively influence on the overall liking, and 1 % oregano oils was liked more than 2 % dues aftertaste (Chi et al. 2006).

One alternative to maybe disguise an undesirable flavor of essential oils is to flavor the essential oils as vanilla, strawberry and banana in different concentrations; results suggested that strawberry aroma with thymol and vanilla with thymol, carvacrol and cinnamaldeyde are a good combined organoleptic profile (Gutiérrez et al. 2009).

However, the use of active packaging containing essential oils as rosemary, oregano in meat showed effect in protecting color discoloration for concentrations higher than 0.5 % (Camo et al. 2011; Nerín et al. 2006).

Conclusions

Despite the low sodium content added on restructured chicken steaks, the use of oregano, potassium sorbate or oregano with potassium sorbate by active films as effective against the microbial development, maintaining the microbiology quality of the products during 150 days of frozen storage, and the use of 1 % or 0.5%of oregano, the natural active compounds reduced more than 50 % lipid oxidation when compared to control, reducing rancidity oxidative.

Active packaging may potentially provide quality due to its important role in reducing the risk of pathogen contamination and delay in quality oxidative, as well as extending shelf life for meat products, associated to such factor, the use of starch to produce such packaging results in a biodegradable film, thus reducing the negative environmental impact.

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