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Effect of olive leaves on the quality of chicken meat during frozen storage

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Abstract

It was held supplementation of olive leaves (OL) in the diet of Cobb's broiler of the 5 and 10 g of leaves per kg of feed and subsequently evaluated the physico-chemical and sensory characteristics of the meat of the thighs and drumsticks for 120 days under frozen storage at -18°C. The use of 5 g of OL reduced the TBARs value, peroxide value and carbonyl protein. The meat of chicken that had received OL largest CRA values and lower losses by exudation during storage. The thighs and drumsticks of treatments with OL, developed fewer taste and odor of rancid, and stood juicier and less acidic than the treatment he received traditional diet. These results suggest the use of OL on chicken diet in order to improve the oxidative stability, chemical physical and sensory frozen meat stored.

Introduction

In 2011 the Brazilian production of chicken meat reached the milestone of 13,058 million tons, ensuring Brazil a position among the top three world producers, with the United States and China. Of this total, 69% remain in the domestic market, which proves the strength of this industry for the country. In exports the Brazil has since 2004 the world's largest exporter position, ending 2011 with a mark of 3.9 million tons shipped to over 150 countries. With this performance, the Brazilian chicken meat has further increased its presence on the table of consumers in Brazil and in the world representing an important food in the human diet, not only for protein but also of minerals and B vitamins Due to its high nutritional value, has received attention as regards the conservation of its functional properties, in order to ensure a final product of good quality to consumers (Ubabef, 2012).

The chicken meat contains lipids, which are likely to suffer autoxidativas reactions, and their meat cuts due to disruption of cellular membranes caused in the mechanical separation process, facilitate the interaction of pro-oxidants with the unsaturated fatty acids present in the flesh resulting in free radical generation and propagation of oxidative reactions. To slow the oxidation stages in processing and storage of the raw material or cuts, is often more effective than direct addition of the preservative, perform supplementation of the diet in growing animals (Govaris *et al*., 2010). The phenolic compounds occurring naturally in plants and are present in the Mediterranean diet via olives and olive emerge as natural alternatives which compounds have antioxidant activity and promote health benefits (Ryan *et al*., 2002).

Botsoglou *et al.* (2010) conducted dietary supplementation of 5 turkeys and 10 g leaves of olive trees / kg feed and evaluated lipid oxidation of steaks stored at ± 4°C for 12 days by TBARs and obtained a significant delay ($P<0.05$) in lipid oxidation of fillets who received addition of olive leaves compared to control treatment. The authors indicated that inhibition of lipid oxidation was probably the result of the antioxidant activity of several components which entered the circulatory system, and were distributed and retained in turkey tissues. Paiva-Martins *et al.* (2009) review the chops which had pig diets supplemented with olive leaves in amounts of 5 to 10 g/kg of feed obtained numbers significantly ($P<0.05$) lower peroxide content and dienes conjugates for the supplemented treatments compared to that received standard diet. When evaluating the effect of supplementation of olive leaves in the amount of 5 to 10 g leaves/kg of diet of pigs Botsoglou *et al.* (2012), found that the pig muscle from these treatments stored refrigerated at 4°C for 9 days, had significant reductions in fat oxidation compared to the treatment which received standard diet. Paiva-Martins *et al*. (2014) evaluated the effect of incorporation of olive leaves in pig diet on meat quality and verified reduction of backfat thickness and increased amounts of tocopherol.

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However, conjugated dienes, pH and color of the meat of animals fed with olive leaves was similar to that received traditional diet. The present study was conducted to evaluate the effects of supplementation percentage of 5 and 10 g of olive leaves in the feed of chickens Cobb for 42 days and evaluate its effects on the physical chemical and sensory characteristics of the thighs and drumsticks of animals stored at -18°C (±1°C) for 120 days.

Materials and Methods

The leaves of Olive (*Olea europaea* L.) variety Ascolana were collected between January and March 2012, an olive grove 5 years of Epagri Chapecó - SC. The leaves were dried at 45°C with air circulation for 72 hours and milled for 1 mm. The milled leaves were supplemented to feed the chickens through three treatments: the first, called T1 (control) received traditional diet, the second, called T2, received diet supplemented with olive leaves in the amount of 5 g of leaves for kg feed, and the third, called T3, received diet supplemented with olive leaves in the quantity of 10 g of leaves for kg of feed.

In this research were used 2,520 broilers Cobb, females. Chickens were raised in an agribusiness in western Santa Catarina being performed 12 repetitions for each treatment through animal housing at random into 36 boxes in the amount of 70 animals/box. After 42 days there was the slaughter of animals and collected the thighs and drumsticks for storage at -18°C (±1°C) for 120 days for monitoring the physical chemical and sensory characteristics of meat. The thighs and drumsticks stored frozen were thawed in refrigerator for 12 hours at temperatures 4-8°C. Refrigerated, the meat was separated skin and bone for analysis.

The lipids were determined by the method of Bligh and Dyer (1959) which consists in the sample fat extraction into chloroform. The protein, moisture and ash were determined according to the methodology described in IN 20, de 21/07/1999 MAPA (BRASIL, 1999). The pH was performed in the muscle, with Digimed (DM-20) pot, using penetration electrode. The aw was performed grinding the drumstick and thigh meat in a blender and performing reading equipment AQUALAB brand, model 3TE at 15°C. The water activity was followed the method described by BARBUT (1996) by homogenization and centrifugation the sample retained in the calculation of the percentage of sample solution.

Performed by measuring liquid exuded by the product with the formula:

$$\%Exudation = \frac{WL(g)x100}{WT(g)}$$

WL = weight of the liquid; WT = total weight

The water activity was followed the method described by BARBUT (1996) by homogenization and centrifugation the sample retained in the calculation of the percentage of sample solution.

To assess the extent of oxidation of the lipids was performed the test substances reactive 2-thiobarbituric acid (TBARs) according to the method described by Wang *et al.* (2002). The peroxide indices was achieved by the method described by LANARA (1981), which evaluates the organic peroxides formed at the beginning of rancidity, which act on potassium iodide by releasing iodine, which is titratable with sodium thiosulfate in the presence of starch.

The conjugated dienes were determined according to the methodology described by Recknagel, (1984). The protein oxidation was determined by the method of Levine *et al*. (1990). A blank sample was performed and then the cultures were placed in a spectrophotometer at 370 nm, zeroing with cap SDS 2%.

The objective color thighs and drumsticks was determined using a Minolta colorimeter CR400, calibrated, operating with illuminant D65 and 10°C, viewing angle, expressed in CIELAB system, values $(L^*a^*b^*)$, where L^* indicates lightness (white ranging from 100% to 0% black), a^* (component red-green) and b^* (yellow-blue component).

For the determination of free fatty acids profile was initially extracted fat from the sample using chloroform method of Bligh & Dyer (1959). Aliquots of the obtained extract, evaporate the chloroform, realized the saponification, esterification and subsequent recovery of the lipids in hexane by the method described by Hartman and Lake (1973).

The Quantitative Descriptive Analysis (QDA) analysis followed the methodology described by STONE, BLEIBAUM & THOMAS, (2012), being divided into the following three steps. First stage - selection of evaluators: A pre-selection of 20 tasters, chicken meat eaters, who showed interest and availability of time in the period when the analysis was performed, comprised 11 females aged between 20 and 37 years and 9 male, aged between 19 and 42 years. Judges were previously selected using triangular test. The criteria for selection of tasters was at least 60% accuracy in total tests. second step - survey of descriptors/development methodology: The survey attributes was performed using the network method. Six sessions were held for lifting descriptive terms of samples of thighs and drumsticks and discussion between the leader and the tasters, the chips lists attributes were defined and developed with the intensity scales of the attributes that the assessors reported to the leader. Was used in this

work unstructured scale 10 cm. third step - training: Was carried out with the products themselves to be evaluated and the reference material, which were presented to the tasters, representative samples of the scale of extremes for each sensory attribute. Fourth stage - sensory test: The sensory evaluation was Performed for the three treatments of thighs and drumsticks, T1, T2 and T3, on the 1st and 120 days of storage at -18°C. The thighs and drumsticks were thawed in refrigerator for 12 hours, a temperature of 4 to 8°C. Samples were prepared in oven at 180°C until core temperature of 83°C. Pieces were separated of thighs and drumsticks, and served in containers with numerical coding of three digits. The QDA was held in sensory analysis laboratory in individual booths, using white light.

Analyses were performed in triplicate, and were subjected to analysis of variance (ANOVA) using the randomized complete block design and the means were compared by Tukey test at 5% error probability by Statistica program - Stat Soft version 7.

Results and Discussion

The determination of lipids (Table 1) samples of the thighs and drumsticks indicated initial values of 7,04%; 7,10% and 7,02% for T1, T2 and T3, respectively. During the four month tracking no significant difference (P>0,05) between treatments. At 30 days the protein values were 18,03%, 18,24% and 18,06% for T1, T2 and T3, respectively. During to the four months to analysis, no significant difference (P>0,05) between treatments. The results varied between 17,95% and 18,24% and were similar to those presented in the Brazilian Table of Food Composition (1998), which indicates values of 17,6% and 17,8% protein for chicken's thighs and drumsticks, respectively.

The moisture percentage reduced for the three treatments during storage, where with 120 days, there was significant percentage (P<0,05) lower for the treatments with the addition of olive leaves compared to control treatment. Whereas all samples were stored under the same condition for packaging and temperature, it can be said that the T1 meat makes this treatment conducive to microbial growth, since Pardi *et al.* (2005) indicates values of 65% to 74% as favorable to microbial growth. In assessing the oxidative stability of chicken, Pino (2005) found higher humidity values than those found in this study, ranging between 68,07% and 70,17%.

The mineral residue values did not differ between treatments during the study period, indicating that the olive leaves dont have influence on this parameter. The initial pH values, of the thighs and drumsticks frozen were 5,89, 5,84 and 5,82 for T1, T2 and T3, respectively, and after 60 days, the treatments have been influenced by the presence of olive leaves, where values T2 and T3 showed diference significantly lower than T1(P<0,05). The high pH for T1 from 60 to 120 days (5,98, 6,06 and 6,06), as reported by Porto (2006) is related to bacteria metabolism processes are more conducive to bacterial growth. Beraquet (2000) found that manually obtained boned thigh meat had a pH of approximately 5,8 to 6,2. Racanicci (2004) found a pH of 6,17 to drumstick chicken, fed diets added of fresh and oxidized poultry offal fat.

The a_w values during the 120 days of follow-up varied between 0,993 and 0,995 for the three treatments and were significantly different from each other, being checked lower values for the treatments with the addition of olive leaves (T2 and T3) compared to T1, the which is indicative of the olive leaves have a positive influence on the parameter aw, therefore a smaller amount of free water for reactions physical, chemical and biological, makes the meat less susceptible to spoilage.

The loss of exudate to the thighs and drumsticks was significantly higher for the treatment he received traditional diet compared to treatments with leaves of olive leaves during the 120 days. Results from lower losses by exudation of treatments with olive leaves in the diet is good for the chicken meat, because according to Jensen *et al.* (1998), the loss of exudate, is a major factor in the decline in the quality of meat products.

The results of Water activity (WHC) assessed the thighs and drumsticks chicken indicate WHC values significantly (P<0,05) higher for the treatments with addition of olive leaves via the diet in relation to the treatment which received standard diet over the 120 days of storage at -18°C. According Huallanco (2004) is equivalent to a high WHC greater juiciness, bigger palatability and sensory perception with consequent improvement of meat quality, indicating the positive effect of olive leaves for this parameter. The muscle tissue WHC is very important during storage of meat, and when the tissue has poor WHC occur moisture losses and consequent increase exudation during storage. This relationship was observed in these study in the 1 to 120 days of monitoring, noting that smaller WHC values are more prone to loss of exudate.

The treatments with the addition of olive leaves had higher values compared to T1 for WHC and consequently had lower exudation values. The treatments with lower exudation (T2 and T3) too had lower pH compared to T1 during to the 120 days of storage. Vieira (2007), when evaluating chicken

Table 1. Mean values lipid, protein, moisture, fixed mineral residue, pH, a_w, exudation and WHC thighs and drumsticks storage frozen at -18°C (±1°C) for 120 days

Parameters		Storage time (Days)				
		1	30	60	90	120
Lipid (g kg^{-1})	T1	6,836^{b}	7,043^{a}	7,010^{a}	7,040^{a}	7,060^{a}
	T2	9,284^{a}	7,103^{a}	7,100^{a}	7,050^{a}	7,013^{a}
	T3	5,807^{b}	7,026^{a}	7,083^{a}	7,076^{a}	7,060^{a}
Protein (g kg^{-1})	T1	18,070^{a}	18,030^{a}	18,023^{a}	17,950^{a}	17,986^{a}
	T2	18,050^{a}	18,246^{a}	18,076^{a}	18,000^{a}	18,043^{a}
	T3	18,011^{a}	18,060^{a}	18,046^{a}	17,980^{a}	18,043^{a}
Moisture (%)	T1	69,473^{a}	69,960^{a}	68,960^{a}	67,600^{a}	66,900^{a}
	T2	67,750^{a}	67,767^{c}	67,700^{b}	66,267^{b}	65,233^{b}
	T3	68,267^{a}	68,700^{b}	68,100^{b}	66,617^{b}	65,266^{b}
Fixed mineral residue (%)	T1	0,917^{a}	0,910^{a}	0,910^{a}	0,913^{a}	0,913^{a}
	T2	0,920^{a}	0,915^{a}	0,917^{a}	0,915^{a}	0,918^{a}
	T3	0,927^{a}	0,915^{a}	0,913^{a}	0,913^{a}	0,910^{a}
pH	T1	5,897^{a}	5,917^{a}	5,987^{a}	6,060^{a}	6,060^{a}
	T2	5,840^{a}	5,890^{a}	5,910^{b}	5,943^{b}	5,933^{b}
	T3	5,820^{b}	5,807^{b}	5,917^{b}	5,930^{b}	5,953^{b}
aw	T1	0,995^{a}	0,995^{a}	0,994^{a}	0,993^{a}	0,993^{a}
	T2	0,994^{b}	0,993^{b}	0,992^{b}	0,991^{b}	0,991^{b}
	T3	0,994^{b}	0,994^{b}	0,993^{b}	0,992^{b}	0,992^{b}
Exudation (%)	T1	1,087^{a}	1,087^{a}	1,115^{a}	1,258^{a}	1,430^{a}
	T2	1,103^{a}	0,960^{b}	0,981^{b}	1,077^{b}	1,070^{b}
	T3	0,830^{b}	0,783^{c}	0,813^{c}	0,826^{c}	0,840^{c}
WHC (%)	T1	19,200^{b}	18,903^{c}	19,467^{c}	19,857^{b}	19,910^{b}
	T2	19,670^{b}	19,443^{b}	19,723^{b}	19,973^{b}	20,010^{b}
	T3	20,310^{a}	19,917^{a}	20,233^{a}	20,543^{a}	20,657^{a}

T1(Control), T2(5 g of olive leaves) e T3(10 g of olive leaves). a, b, c are analyzed vertically between the three treatments in the same range. Different letters show significant differences (P<0,05) by Tukey test.

breast fillets, found increased loss of exudate with decreasing pH, different from those found in this study. The decrease in pH, causes denaturation of proteins that bind the water in the meat, accumulating moisture out of cells, in the interstitial space. Protein denaturation caused by the lowering of pH has not occurred in this study, indicating that the olive leaves, improved WHC to the chicken thighs and drumsticks, even at significantly lower pH than T1.

The mean values of TBARs for thighs and chicken drumsticks were 0,059; 0,045 and 0,089 mg MDA/kg sample at the beginning of the experiment and 0,177; 0,155 and 0,125 mg MDA/kg sample at the end of 120 days for T1, T2 and T3, respectively (Table 2). This result indicated lower values for treatments with the addition of olive leaves via diet, demonstrating trend of lower oxidation. The number of TBARs for the three treatments experienced a slight increase after freezing, which according to Pino (2005), may have occurred because of possible dehydration caused by low temperature, which results in a lower aw, favoring lipid deterioration. Racanicci (2004), who also worked with chicken drumsticks, found the same rise behavior of TBARs values in the initial period of frozen storage, where their initials values ranged from 0,160 to 0,474 mg malonaldehyde/kg for the fifth month the analysis. Verma and Sahoo (2000), indicated MDA concentrations between 1-2 mg/kg as the threshold values to detect rancidity. Chouliara (2008) determined values of 3 MDA/kg of meat which are associated with oxidative rancidity. Considering these values, the thighs and drumsticks chicken for this study were great, with MDA values well below mentioned by Verma and Sahoo (2000) and Chouliara *et al.* (2008).

The freezing reduced the peroxide value of the three treatments comparing the first day of analysis to other days of monitoring, indicating that the temperature has a positive effect on peroxides. The peroxide index values found on the thighs and chicken drumsticks showed significant differences (P<0,05) between treatments from 30 to 120 days of storage. The treatments with addition of olive leaves showed lower peroxide values that T1, indicating that the addition of olive leaves via broiler feed is capable of delaying the onset of oxidative process. Peroxides values above 5 mEq/kg fat, indicate undesirable sensory characteristics and already noticeable on the palate, and values above 10 mEq make the product unsuitable for consumption, featuring a breakthrough in the rancidity process (Feddern *et al.*, 2010). Therefore, the peroxide values presented in this study were lower compared to those cited by Feddern *et al.* (2010), indicating that the lipid oxidation in chicken thighs and drumsticks, not caused damage to the quality of the product.

The analysis of conjugated diene showed no significant difference (P>0,05) between treatments, indicating that olive leaves dont show influence on this parameter. The freezing reduced the amount of

Table 2. Mean values TBARs, Peroxide value, Conjugated diene, and Protein carbonyls thighs and drumsticks storage frozen at -18°C (±1°C) for 120 days

Parameters		Storage time (Days)				
		1	30	60	90	120
TBARs (MDA equivalents, µg/Kg)	T1	0,059 [a]	0,150 [a]	0,075 [a]	0,082 [a]	0,177 [a]
	T2	0,045 [a]	0,030 [b]	0,059 [a]	0,079 [a]	0,155 [a,b]
	T3	0,089 [a]	0,087 [b]	0,065 [a]	0,085 [a]	0,125 [b]
Peroxide value (mEq peroxide/kg)	T1	0,179 [a]	0,000994 [a]	0,001391 [a]	0,000259 [a]	0,001640 [a]
	T2	0,147 [a]	0,000003 [b]	0,000009 [b]	0,000001 [b]	0,000013 [b]
	T3	0,349 [a]	0,000010 [b]	0,000008 [b]	0,000001 [b]	0,000011 [b]
Conjugated diene (abs./mg lip./ml cicloh)	T1	0,259 [a]	0,205 [a]	0,194 [a]	0,241 [a]	0,154 [a]
	T2	0,251 [a]	0,228 [a]	0,218 [a]	0,254 [a]	0,174 [a]
	T3	0,311 [a]	0,245 [a]	0,198 [a]	0,280 [a]	0,160 [a]
Protein Carbonyls (nmol/mg protein)	T1	1,235 [a]	0,099 [a]	0,178 [a]	0,115 [a]	0,070 [a]
	T2	1,015 [a]	0,082 [a]	0,159 [a]	0,091 [a]	0,089 [a]
	T3	0,973 [a]	0,064 [a]	0,183 [b]	0,077 [b]	0,050 [b]

T1(Control), T2(5g of olive leaves) e T3(10g of olive leaves). a, b, c are analyzed vertically between the three treatments in the same range. Different letters show significant differences (P<0,05) by Tukey test.

conjugated diene of the three treatments from 30 to 120 days, but with no significant difference. Paiva-Martins *et al*. (2009) evaluated content the dienes conjugates for pigs with diet supplemented with 5% and 10% olive leaves, and after 8 days of storage at 4°C, they found six times higher values for the control treatment.

The protein oxidation to the thighs and drumsticks reduced their values to 90 to 120 days of storage. The fact that it decreased the values, can be related to the fact that with increasing amount of secondary products of lipid oxidation (TBARs), formation of carbonyl compounds derived from the protein oxidation is still growing, and achieve a higher level later (Lund *et al*., 2011). At 90 and 120 days there was an increase in TBARs values and in this period there was a reduction of protein carbonyls. So there seems to be a relationship between the secondary products of oxidation and formation of carbonyl compounds. Soyer *et al.* (2010) studied chicken breast meat supplemented with standard diet for 6 months at -18°C and found at 120 days of storage 1,5 ηmol carbonyl/mg protein, with an increase in the amount of carbonylated protein over time, reaching a maximum value of 1,9 ηmol carbonyl/mg protein after 180 days of storage under freezing indicating that the storage time has great impact on the protein oxidation of meat. The treatment that received olive addition of 10g/kg of feed showed values significantly lower (P<0,05) to the carbonylated proteins that T1 and T2, at 90 and 120 days of monitoring, indicating that the olive leaves has a positive effect on the meat.

Regarding the color, thighs and drumsticks belonging to treatment T2 showed higher L^* values at 30, 60 and 120 days compared to T1 and T3 (Table 3). Amateur (2013) when analyzing meat for thighs and drumsticks chickens with fed diets containing different natural antioxidants, found L^* value ranging from 46,63 to 48,58 and pH 5,97 to 6,16. Comparing the results of this study with those found by Amador (2013), it was perceived similarity in pH values and L^* for this study, but we can not say that the leaves of olive trees given to chickens influenced the values of L^*, once the treatments were not significantly different (P<0,05) between them. Le Bihan-Duval *et al.* (1999) observed that the largest values of L^* were associated with the greatest losses of water by exudation. This result did not occur on the thighs and drumsticks frozen. However, when we compare the values of L^* and water loss by exudation of frozen thighs and drumsticks, with the 1st day of analysis thighs and drumsticks refrigerated, L^* and exudation of T1, T2 and T3, respectively, are observed higher values L^* and further loss of exudation, agreeing with what was observed by Le Bihan-Duval *et al.* (1999).

The values of L^*, a^*, b^* oscillated during the 120 days of analysis, not showing trend between samples. This result indicates that the olive leaves added via diet did not promote color changes on the thighs and drumsticks of chickens T3 and T2 in relation to the treatment he received conventional diet (T1). The profile of free fatty acids (Table 4) indicated no significant difference (P>0.05) between treatments. During the 120 days fatty acids found in thighs and drumsticks chicken do not suffer variation in their percentages, demonstrating that lowering the temperature exerts no significant effect on this parameter.

The QDA on the thighs and drumsticks chicken, indicated significant reduction in the perception for the attributes odor rancid and flavour rancid of the meat that received olive leaves (Table 5). During the 120 days of analysis, the treatment that received traditional diet, showed higher values of odor rancid and flavour rancid, indicating that the olive leaves have the ability to retard the development of these

Table 3. Mean values Color *(L*, a*, b*)* thighs and drumsticks storage frozen at -18°C (±1°C) for 120 days

Parameter	Storage time (Days)	T1	T2	T3
L* thighs	1	57,58 ^{a}	56,15 ^{a}	56,69 ^{a}
	30	76,537 ^{b}	82,863 ^{a}	80,483 ^{a}
	60	59,203 ^{ab}	61,027 ^{a}	54,910 ^{b}
	90	63,250 ^{a}	54,813 ^{c}	58,820 ^{b}
	120	55,557 ^{a}	58,707 ^{a}	56,650 ^{a}
L* drumsticks	1	54,56 ^{a}	52,78 ^{a}	54,40 ^{a}
	30	74,800 ^{a}	77,950 ^{a}	76,367 ^{a}
	60	54,083 ^{b}	59,010 ^{a}	55,090 ^{b}
	90	59,267 ^{a}	51,903 ^{b}	56,467 ^{a}
	120	52,350 ^{b}	58,793 ^{a}	57,267 ^{a}
a* thighs	1	17,31 ^{a}	13,45 ^{a}	14,37 ^{a}
	30	7,217 ^{a}	4,163 ^{b}	7,440 ^{a}
	60	16,413 ^{a}	14,240 ^{a}	18,843 ^{a}
	90	12,693 ^{b}	18,700 ^{a}	14,137 ^{b}
	120	17,040 ^{a}	16,653 ^{a}	17,133 ^{a}
a* drumsticks	1	13,95 ^{a}	16,76 ^{a}	15,90 ^{a}
	30	11,290 ^{a}	5,520 ^{b}	7,197 ^{b}
	60	16,433 ^{a}	14,780 ^{a}	17,417 ^{a}
	90	15,330 ^{c}	20,687 ^{a}	17,583 ^{b}
	120	20,010 ^{a}	19,233 ^{a}	15,117 ^{b}
b* thighs	1	8,57 ^{b}	15,66 ^{a}	14,24 ^{a}
	30	2,047 ^{a}	3,820 ^{a}	3,140 ^{a}
	60	15,680 ^{a}	12,680 ^{a}	14,840 ^{a}
	90	13,133 ^{a}	11,827 ^{a}	10,950 ^{a}
	120	8,093 ^{b}	13,717 ^{a}	14,003 ^{a}
b* drumsticks	1	10,42 ^{a}	11,77 ^{a}	12,20 ^{a}
	30	1,347 ^{b}	8,227 ^{a}	2,723 ^{ab}
	60	12,243 ^{a}	14,067 ^{a}	11,617 ^{a}
	90	16,127 ^{a}	10,957 ^{a}	12,660 ^{a}
	120	9,533 ^{b}	17,763 ^{a}	9,133 ^{b}

T1(Control), T2(5 g of olive leaves) e T3(10 g of olive leaves). a, b, c are analyzed vertically between the three treatments in the same range. Different letters show significant differences (P<0,05) by Tukey test.

attributes in the meat.

For flavour olive oil and odor of olive oil, the tasters initially gave high marks to T2 and T3, with difference significantly from each other (P<0,05) and compared to T1, indicating that the incorporation of olive leaves in the feed of chickens contributed to the modification of the flavour and odor of the meat of the thighs and drumsticks, giving sensory notes not observed in T1. After 120 days the notes for T2 and T3 were lower indicating that the components have been degraded during frozen storage. The intensity of the green color and initial color greenish were higher for treatments with olive leaves, indicating change in color of the meat, because the higher the percentage of olive leaves added in the diet, the higher the scores awarded by tasters to treatment.

After 120 days, these attributes reduced for T2 and T3 and increase to T1, indicating that the olive leaves have interference positive in coloration of the thighs and drumsticks chicken, because the intensity of green and greenish attributes, indicative the heme pigment oxidation, increased to T1 over time, and T2 and T3 levels decreased, most likely by degradation of green pigment initially conferred by olive leaves for the thighs and drumsticks chicken. The brightness of the thighs and drumsticks, and the color yellowish, regarding the fat began more intense for T2 and T3 compared to T1. But over monitoring, the values changed, ending close between treatments. The meat texture, assessed by attributes firm and juice, indicated initial values higher for juiciness T2 and T3 these being significantly (P<0,05) more juice than T1. The greater juiciness of treatments with olive leaves remained during the 120 days the storage, and the stiffness was significantly (P<0,05) higher for T1 at 120 days compared to T2 and T3.

For the flavor fresh chicken attribute, T1 received lower grades during 120 days of analysis, which indicates that T1 lost the initial freshness of meat on the first day of analysis. The odor chicken, was higher for T1 compared to treatments with olive leaves. These results indicate that, the addition of olive leaves provide longer freshness of meat, without increasing their odor chicken, that is associated with organoleptic change. The acid taste was also influenced by the inclusion of olive leaves via the diet of chickens where the thighs and drumsticks, during the 120 days of storage, for T2 and T3 showed lower values than T1, indicating that the use of olive via diet preserved the sensory characteristics of the evaluated cuts.

Conclusion

The use of 5 g of olive leaves per kg of feed has reduced protein and lipid oxidation in chicken meat. Thighs and drumsticks of chickens treated with olive

Table 4. Mean values Profile of free fatty acids thighs and drumsticks storage frozen at -18°C (±1°C) for 120 days

Parameter		Storage time (Days)			
		30	60	90	120
∑ (SFA)	T1	32,72	32,08	30,36	32,32
	T2	31,56	31,29	31,45	32,44
	T3	31,21	31,65	31,44	31,33
∑ (MUFA)	T1	43,11	43,24	41,74	45,05
	T2	46,49	43,56	41,48	43,95
	T3	45,32	44,94	42,62	46,55
∑ (PUFA)	T1	21,11	22,10	23,34	21,79
	T2	19,32	21,68	18,30	19,75
	T3	20,55	20,00	20,29	19,94
C 14:0	T1	0,87 ^{a}	0,45 ^{a}	0,41 ^{a}	0,49 ^{a}
	T2	0,61 ^{a}	0,41 ^{a}	0,41 ^{a}	0,45 ^{a}
	T3	0,46 ^{a}	0,48 ^{a}	0,45 ^{a}	0,48 ^{a}
C 15:0	T1	0,11 ^{a}	0,58 ^{a}	0,54 ^{a}	0,06 ^{a}
	T2	0,11 ^{a}	0,65 ^{a}	0,32 ^{a}	0,07 ^{a}
	T3	0,10 ^{a}	0,67 ^{a}	0,26 ^{a}	0,06 ^{a}
C 16:0	T1	23,13 ^{a}	22,67 ^{a}	21,34 ^{a}	23,83 ^{a}
	T2	23,04 ^{a}	21,94 ^{a}	22,65 ^{a}	24,06 ^{a}
	T3	22,93 ^{a}	22,06 ^{a}	22,49 ^{a}	23,92 ^{a}
C 18:0	T1	8,29 ^{a}	7,84 ^{a}	7,53 ^{a}	7,44 ^{a}
	T2	7,47 ^{a}	7,80 ^{a}	7,53 ^{a}	7,43 ^{a}
	T3	7,31 ^{a}	7,92 ^{a}	7,71 ^{a}	6,48 ^{a}
C 22:0	T1	0,13 ^{a}	0,35 ^{a}	0,35 ^{a}	0,28 ^{a}
	T2	0,12 ^{a}	0,27 ^{a}	0,35 ^{a}	0,26 ^{a}
	T3	0,19 ^{a}	0,27 ^{a}	0,34 ^{a}	0,17 ^{a}
C 22:0	T1	0,13 ^{a}	0,35 ^{a}	0,35 ^{a}	0,28 ^{a}
	T2	0,12 ^{a}	0,27 ^{a}	0,35 ^{a}	0,26 ^{a}
	T3	0,19 ^{a}	0,27 ^{a}	0,34 ^{a}	0,17 ^{a}
C 16:1	T1	4,04 ^{a}	4,44 ^{a}	4,10 ^{a}	4,70 ^{a}
	T2	4,53 ^{a}	2,89 ^{a}	1,70 ^{a}	3,24 ^{a}
	T3	4,22 ^{a}	4,56 ^{a}	4,87 ^{a}	5,37 ^{a}
C 18:1 n9	T1	38,22 ^{a}	36,98 ^{a}	37,32 ^{a}	38,15 ^{a}
	T2	41,11 ^{a}	37,81 ^{a}	38,92 ^{a}	38,59 ^{a}
	T3	40,23 ^{a}	37,20 ^{a}	37,12 ^{a}	39,71 ^{a}
C 20:1	T1	0,31 ^{a}	0,24 ^{a}	0,31 ^{a}	0,30 ^{a}
	T2	0,32 ^{a}	1,07 ^{b}	0,30 ^{a}	0,28 ^{a}
	T3	0,28 ^{a}	1,17 ^{b}	0,31 ^{a}	0,25 ^{a}
C 18:2 n6	T1	19,53 ^{a}	20,64 ^{a}	21,78 ^{a}	20,38 ^{a}
	T2	17,96 ^{a}	20,40 ^{a}	18,13 ^{b}	18,50 ^{a}
	T3	19,49 ^{a}	19,69 ^{a}	19,20 ^{ab}	18,62 ^{a}
C 20:2	T1	0,17 ^{a}	0,22 ^{a}	0,19 ^{a}	0,14 ^{a}
	T2	0,09 ^{a}	0,29 ^{a}	0,17 ^{a}	0,14 ^{a}
	T3	0,08 ^{a}	0,30 ^{a}	0,15 ^{a}	0,10 ^{a}

T1(Control), T2(5 g of olive leaves) e T3(10 g of olive leaves). a, b, c are analyzed vertically between the three treatments in the same range. Different letters show significant differences (P<0,05) by Tukey test.

Table 5. Mean values of QDA analysis of the thighs and drumsticks on the 1 and 120 days of storage frozen at -18°C (±1°C)

Attributes evaluated	Storage time (Days)					
	1day storage			120 days storage		
	T1	T2	T3	T1	T2	T3
Intensity of the green color	2,10 ^{c}	4,36 ^{b}	5,23 ^{a}	2,42 ^{b}	4,56 ^{a}	4,65 ^{a}
Brightness	4,53 ^{c}	4,56 ^{b}	4,81 ^{a}	3,93 ^{a}	3,70 ^{a}	3,80 ^{a,b}
Light color	0,54 ^{c}	0,81 ^{b}	1,13 ^{a}	0,56 ^{c}	0,65 ^{b}	0,92 ^{a}
yellowish	3,60 ^{c}	3,86 ^{a}	3,80 ^{a}	3,53 ^{a}	3,45 ^{a,b}	3,38 ^{b}
greenish	1,73 ^{c}	6,40 ^{b}	7,33 ^{a}	3,60 ^{c}	4,55 ^{b}	5,83 ^{a}
Odor chicken	6,20 ^{a}	4,96 ^{b}	4,30 ^{c}	6,18 ^{a}	4,40 ^{b}	3,96 ^{c}
Odor of olive oil	0,08 ^{c}	7,83 ^{b}	8,63 ^{a}	0,00 ^{c}	5,82 ^{b}	6,46 ^{a}
Odor rancid	1,40 ^{a}	0,50 ^{c}	0,80 ^{b}	2,55 ^{a}	0,87 ^{b}	0,97 ^{b}
Juice	5,07 ^{b}	5,28 ^{ab}	5,40 ^{a}	4,96 ^{a}	4,98 ^{a}	4,96 ^{a}
firm	4,97 ^{a}	4,60 ^{b}	4,76 ^{ab}	4,90 ^{a}	4,41 ^{b}	4,42 ^{b}
Flavor fresh chicken	7,76 ^{b}	7,90 ^{b}	8,36 ^{a}	6,47 ^{b}	7,10 ^{a}	7,39 ^{a}
Flavor rancid	2,41 ^{a}	0,76 ^{c}	1,57 ^{b}	3,45 ^{a}	1,25 ^{b}	1,38 ^{b}
Flavor acid	3,41 ^{a}	1,16 ^{c}	1,97 ^{b}	3,56 ^{a}	1,92 ^{b}	1,81 ^{b}
Flavor olive oil	0,50 ^{c}	7,96 ^{b}	9,16 ^{a}	0,00 ^{c}	6,18 ^{b}	7,85 ^{a}

T1 Treatment (control), T2 (5 g olive) and T3 (10 g olive), a, b, c are analyzed horizontally between T1, T2 and T3 interval for analysis. Different letters show significant differences (P<0,05) by Tukey

leaves had lower losses and higher exudation CRA values during storage. The olive leaves delayed the formation of rancid flavors and odors and provided higher juiciness and lower acidity for chicken meat.

References

Amador, S.A. 2013. Aspectos físicos da carne do peito, da coxa e da sobrecoxa de frango alimentados com dietas contendo antioxidantes naturais. Brasília: Universidade de Brasília, MSc thesis.

Barbut, S. 1996. Estimates and detection of the PSE problem in young turkey breast meat. Canadian Journal of Animal Science 76: 455-457.

Beraquet, N.J. 2000. Carne mecanicamente separada de aves. p.1-92. Campinas: ITAL.

Bligh, E. G. and Dyer, W. J. 1959. A raphid method of total lipid extraction and purification. Can. J. Biochem. Physiology 37: 911-917.

Botsoglou, E., Govaris, A., Christaki, E. and Botsoglou, N. 2010. Effect of dietary olive leaves and/or a-tocopheryl acetate supplementation on microbial growth and lipid oxidation of turkey breast fillets during refrigerated storage. Food Chemistry 121: 17-22.

Botsoglou, E., Govaris, A., Ambrosiadis, I. and Fletouris, D. 2012. Lipid and protein oxidation of α-linolenic acid-enriched pork during refrigerated storage as influenced by diet supplementation with olive leaves (*Olea Europea* L.) or α-tocopheryl acetate. Meat Science 92: 525-532.

Brazil, Ministério da Agricultura, Pecuária e Abastecimento, Secretaria da Defesa Agropecuária, Instrução Normativa n°20, de 21 de julho de 1999. Métodos Analíticos físico-químicos para controle de produtos cárneos e seus ingredientes – sal e salmoura. Diário Oficial da União, Brasília, DF, 9 set. Seção 1.

Chouliara, E., Badeka, A., Savvaidis, L. and Kontominas, M. G. 2008. Combined effect of irradiation and modified atmosphere packaging on shelf-life extension of chicken breast meat: Microbiological, chemical and sensory changes. European Food Research and Technology 226: 877-888.

Feddern, V., Kupski, L., Cipolatti, E.P., Giacobbo, G., Mendes, G.L., Badiale-Furlong, E. and Souza-Soares, L.A. 2010. Physico-chemical composition, fractionated glycerides and fatty acid profile of chicken skin fat. European Journal Lipid Science Technology 112: 1277-1284.

Govaris, A., Botsoglou, E., Moulas, A. and Botsoglou, N. 2010. Effect of dietary olive leaves and rosemary on microbial growth and lipid oxidation of turkey breast during refrigerated storage. South African Journal of Animal Science 40: 154–155.

Hartman, L. and Lago, B. C. A. 1973. Rapid preparation of fatty acid methyl esters from lipids. Lab. Pract 22: 475-477.

Huallanco, M.B.A. 2004. Aplicação de um sistema de classificação de carcaças e cortes e efeito pós abate da qualidade de cortes de frango criados no sistema alternativo. Piracicaba: Escola Superior de Agricultura Luiz de Queiroz, MSc thesis.

Jensen, C. Lauridsen, C. and Bertelsen, G. 1998. Dietary vitamin E: quality and storage stability of pork and poultry. Trends Food Science Technology 9: 62-72.

Lanara. 1981. Métodos Analíticos Oficiais para Controle de Produtos de Origem Animal e seus Ingredientes. II – Métodos físico químicos. Brasília, Ministério da Agricultura.

Le Bihan-Duval, E. Millet, N. and Remignon, H. 1999. Broiler meat quality: effect of selection for increased carcass quality and estimates of genetic parameters. Poultry Science 78: 822-826.

Levine R. L., Garland D., Oliver C. N., Amici A., Climent I., Lenz A. G., Ahn B. W., Shaltiel S. and Stadtman E. R. 1990. Carbonyl assays for determination of oxidatively modified proteins. Methods in Enzymology 186: 464-478.

Lund, M. N, Heinonem, M., Baron, C.P. and Estevez, M. 2011. Protein oxidation in muscle foods: A review. Mol. Nutr. Food Res 55: 83-95.

Paiva-Martins, F., Barbosa, S., Pinheiro, V., Mourão, J.L. and Outor-Monteiro, D. 2009. The effect of olive leaves supplementation on the feed digestibility, growth performances of pigs and quality of pork meat. Meat Science 82: 438–443.

Paiva-Martins, F, Ribeirinha, T, Silva, A, Gonçalves, R, Pinheiro, V, Mourão, J.L. and Outor-Monteiro, D. 2014. Effects of the dietary incorporation of olive leaves on growth performance, digestibility, blood parameters and meat quality of growing pigs. Journal of Science Food and Agriculture 94: 3023-3029

Pardi, M.C., Santos, I.F., Souza, E.R. and Parde, H.S. 2005. Ciência e tecnologia da carne. 2° Ed. V.1. Goiânia, 624p.

Pino, L.M. 2005. Estabilidade oxidativa da carne de frangos alimentados com diferentes fontes lipídicas, armazenada sob congelamento. Piracicaba: Escola Superior de Agricultura Luiz de Queiroz, MSc thesis.

Porto, E. 2006. Qualidade da carne: microbiologia de carnes. p.101-131. São Paulo.

Racanicci, A.M.C. 2004. O efeito do uso do óleo de vísceras de aves oxidado no desempenho de frangos de corte e na estabilidade oxidativa da carne da sobrecoxa. Piracicaba: Escola Superior de Agricultura Luiz de Queiroz, MSc thesis.

Recknagel, R. O. and Glende Jr., E. A. 1984. Spectrophotometric detection of lipid conjugated dienes. Methods Enzymology 105: 331-337.

Ryan, D., Antolovich, M., Prenzler, P., Robards, K. and Lavee, S. 2002. Biotransformations of phenolic compounds in Olea europea L. Scientia Horticulturae 92: 147–176.

Soyer, A., Özap, B., Dalmis, Ü. and Bilgin, V. 2010. Effects of freezing temperature and duration of frozen storage on lipid and protein oxidation in chicken meat. Food Chemistry 120:1025-1030.

Stone, H.; Bleibaum, R.N.; Thomas, H.A. 2012. Sensory evaluation practices. Amsterdam: Academic Press.

Internet: Ubabef. 2012. União Brasileira de Avicultura. Relatório Anual 2010/2011. Downloaded from: *http://www.abef.com.br.* on: 06/01/2015.

Vieira, E.T.T. 2007. A influencia do processo de congelamento na qualidade do peito de frango. URI: Campus Erechim, MSc thesis.

Verma, S.P. and Sahoo, J. 2000. Improvement in the

quality of ground chevon during refrigerated storage by tocoferol acetate preblending. Meat Science 56: 03-413.

Wang, B., Pace, R.D., Dessai, A.P., Bovell-Benjamin, A. and Phillips, B. 2002. Modified Extraction Method for Determining 2-Thiobarbituric Acid Values in Meat with Increased Specificity and Simplicity. Journal of food Science 67: 2833-2836.