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USING NATURAL HERBAL EXTRACTS FOR IMPROVING THE LIPID OXIDATION AND SENSORY ATTRIBUTES OF BEEF BURGER MANUFACTURED WITH MECHANICALLY DEBONED CHICKEN MEAT

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SUMMARY

The main objective of the present study was to examine the visibility of using natural herbal extracts to help meat industry to minimize lipid oxidation, improve sensory characteristics and extend the shelf life of meat products manufactured with mechanically deboned chicken meat (MDCM). A base batter was prepared by using a simple traditional formulation as follows: 50 % lean beef meat, 35 % beef fat, 2 % (w/w)sodium chloride, 5 % (w/w) water, 8 % Hydrated Soya R 50 (1:2 water). This mixture was divided into batches to which the different antioxidants (BHT, marjoram and rosemary) were added at a rate of 0.02 % for each one while 1st group left as control without addition of any antioxidant. Another five batches were prepared by using 20 % of the meat material as MDCM (percentage of lean beef) and the antioxidants were added at the same level with 1st batch was left as control and the combination of marjoram and rosemary (0.02 % each) was used for the 5th batch. Addition of 20 % MDCM into burger patties caused significant reduction in protein content and significant increase in fat content. Burger patties formulated with 20 % MDCM showed significantly higher TBARs values. Addition of herbal extracts (marjoram or rosemary) significantly ($P<0.05$) reduced the TBARs in burger patties formulated with or without MDCM. Treatments of burger patties contain 20 % MDCM with combination of marjoram and rosemary resulted in more reduction in TBARs (synergistic effect). The addition of natural antioxidants to burger patties formulated with MDCM significantly reduced the pH values. Addition of antioxidants to the burger patties significantly increased the sensory scores during the frozen storage period. Natural herbal extracts

specially when combined together offered the most efficient protection against lipid oxidation with improving the sensory attributes at levels applied during frozen storage of burger patties formulated with 20 % MDCM.

INTRODUCTION

Beef burger is one of the most popular meat products that are used as fast meals in Egypt. The increasing price of the raw meat materials has encouraged the food industry to evaluate the possibility for utilization of other raw materials of low cost such as mechanically deboned chicken meat (MDCM). Mechanically deboned chicken meat has the appearance of finely comminuted meat (Crosland et al., 1995) with excellent nutritional and functional properties suitable for formulation of many meat products (Dhillon and Maurer, 1975; Froning, 1981; Fjeld, 1988; Babji and Lim, 1993; Mielnik et al., 2002; Püssa et al., 2008).

Although, mechanically deboned chicken meat is a valuable raw material frequently used in formulation of comminuted meat products, the rapid onset of oxidative rancidity is a major problem for products manufactured with such raw material. The extensive stress and incorporation of oxygen during mechanical deboning process as well as its contents of bone marrow, heme and lipids are the causes of rapid onset of oxidative rancidity (Moerck and Ball, 1974; Dawson and Gartner, 1983). Moreover, it is highly perishable and has a short shelf life even under refrigeration due to the release of cellular fluids rich in nutrients and the heat generated during mechanical deboning (Kummer et al., 1986; Field, 1988). The high microbial load and the liability of oxidation shorten the shelf life of products manufactured with MDCM. However, the storage life can be extended and the auto-oxidation liability can be prevented by the use of antioxidants.

Antioxidants are compounds capable of delaying, retarding or preventing auto-oxidation processes (Shahidi and Wanasundara, 1992). In industrial processing, mainly synthetic antioxidants are used. However; the noxiousness of some antioxidants such as BHT and BHA which are used in food processing has been reported, they can cause carcinogenic effects in living organisms (Baardseth, 1989; Karpinska, 2001). Therefore, natural antioxidants of plant origin have been introduced to improve the lipid stability and enhance the sensory properties of food. The antioxidant properties of natural antioxidants are mainly attributed to their phenolic contents, thus, their antioxidant action is similar to synthetic phenolic antioxidants (Cuvelier et al., 1996). The antioxidation potential of many plant extracts such as rosemary, sage, green tea, cocoa products have been investigated by several authors (Chang et al., 1977; Arts et al., 1999; Kris-Etherton and Keen, 2002).

The objective of the present study was to investigate the feasibility of using selected natural herbal extracts for improoving the lipid stability and sensory characteristics and extending the shelf life of beef burger patties formulated with MDCM. Therefore, to encourage the meat industry to use MDCM for production of high quality meat products without adverse health effects.

MATERIALS AND METHODS

Raw materias:

Frozen mechanically deboned chicken meat was obtained from commercial processing plant at Cairo, Egypt within 2 weeks of manufacture and kept frozen untill as soon as possible after slaughter and transported to the laboratory in an insulated box with minimum of delay. The meat was stored at 4°C overnight before use . Marjoram and rosemary extracts were obtained from Research Institute of Horticulture, Aromatic and Medicinal Plants Division, belonging to Ministry of Agriculture and Land Reclemination (Dokki, Giza, Egypt). Butylated hydroxytoluene was purchesed from Sigma chemical company. Sodium chloride and soya were obtained from local market at Cairo, Egypt.

Burger manufacture:

A base batter was prepared by using a simple traditionl formulation as follows: 50 % lean beef meat, 35 % beef fat, 2 % (w/w)sodium chloride, 5 % (w/w) water, 8 % Hydrated soya R 50 (1:2 water). This mixture was divided into batches to which the different antioxidants [Butylated hydroxytoluene (BHT), marjoram and rosemary] were added at a rate of 0.02 % for each one with 1st group left as control without addition of any antioxidant Another five batches were prepared by using 20 % of the meat material as MDCM (percentage of lean beef) and the antioxidants were added at the same level with 1st batch was left as control and the combination of marjoram and rosemary (0.02 % each) was used for the 5th batch.

For each batch, beef and MDCM were ground through a 5-mm plate mincer, then the water, salt soya and BHT or natural extracts were added. The mixture was mixed for 5 minutes. A burger maker with 9 cm internal diameter was then used to shape this mixture into patties of approximately 70 g and 1 cm thickness. The burger patties were placed in plastic backaging films, frozen at -30°C for 30 minutes and then stored at -18°C for up to 3 months. Samples were withdrawn at 0 time and monthly.

Burger analysis:

Chemical analysis:

A. Proximate analysis:

Moisture, protein, fat and ash contents of burger patties from different batches were determined after the manufacture. For determination of moisture contents, 3 g of each sample were dried at 100°C until constant weight was obtained. Protein content was determined according to the kjel-

dahl method of analysis. For conversion of nitrogen into crude protein, a factor 6.25 was used. Fat content was determined by 6-cycle extraction with petrolium ether in a soxhlet apparatus and calculating the weight loss. Ash was determined by ignition at 500°C for 5h, as the method of AOAC (2000).

B. Deterioration criteria:

B.1 Lipid oxidation (Thiobarbituric acid test, TBA):

Thiobarbituric acid-reactive substances (TBARS) were measured according to the method of Du and Ahn, (2002). Five grams of burger was weight and homogenized with 15 mL of deionized distilled water. One milliliter of the meat homogenate was transferred to a test tube and 50 µL of butylated hydroxytoluene (7.2 %) and 2 mL of thiobarbituric acid (TBA)-trichloroacetic acid (TCA) (15 mM TBA-15% TCA) were added. The mixture was vortexed and then incubated in a boiling water bath for 15 min to develop color. Then sample was cooled in cold water bath for 10 min, vortexed again, and centrifuged for 15 min at 2500 x g. The absorbance of the resulting supernatant solution was determined at 531 nm against a blank containing 1 mL of deionized water and 2 mL of TBA-TCA solution. The amounts of TBARS were expressed as milligrams of malonaldehyde per kilogram of meat.

B.2. The pH measurement:

Ten grams of sample was homogenized with 90 ml deionized water for 2 minutes and the pH was measured using digital pH meter (Suntex TS-1) with probe type combined electrode (Ingold) through immersing the electrode directly into the mixture.

Bacterial analysis:

Ten grams from the center of each burger patty were separately homogenized with 90 ml Ringer's solution (Merck) in a stomacher (Lab-blender 400, Seward, UAC house friars Road. London SE 19 UG. Model No. 6021) for 1.5 minutes. Psychrotrophic bacterial counts were determined using plate count agar (Oxoid) and the plates were incubated at 7°C for 10 days (APHA, 1992).

Sensory evaluation:

For sensory evaluation of burger patties, five assessors were selected from the staff members of the Department of Food Hygiene and Control, Faculty of Veterinary Medicine, Cairo University, Egypt. They received a preparatory session prior to tesing so that each panel could thoroughly discuss and clarify each attribute to be evaluated. Three burger patties from each formula were cooked at 150°C in a forced draught oven to a core temperature 72°C and maintained warm in the oven until testing within 3-8 minutes (Fernåndez-Lopez et al., 2006). From the center of each burger patty, rectangular pieces of approximately 1.5cm x2 were cut and served at room temperature. Each panelist evaluated three replicates of all formulas in a randomized order

and asked to give score from 1 to 10 (1, very poor and 10, excellent) for flavor, tenderness and juiciness. Tap water was provided between samples to cleanse the palate. At the end of evaluation of each burger patty, each panelist was asked to give a score for overall acceptability from 1 to 10.

Statistical analysis:

Statistical data analysis was carried out using Minitab Statistical Program (Minitab Inc., State College, Pa.). One-way analysis of variance was performed to compare the effect of the treatments. Multiple comparisons of means were done using Tukey's at family error rate 0.05.

RESULTS AND DISCUSSION

Results of chemical composition of different formulas of burger patties are presented in Table 1. Batches of burger patties formulated with 20 % MDCM exhibited significant ($P<0.05$) reduction in protien content and significant ($P>0.05$) increase in fat content. This could be probably attributed to the lower protien content and higher fat content of MDCM (Gruden, 1972; Dhillon and Maurer, 1975; MacNeil et al., 1978; Uebersax et al., 1978). Significant ($P<0.05$) reduction of the protien content and significant increase in the fat content of chicken nuggets formulated with 20 % washed MDCM were observed by Perlo et al. (2006). High fat content and lower protien contents for MDCM were recorded by different authors (Froning, 1981; Lawrie, 1991; Crosland, 1995). However, there were no significant ($P>0.05$) changes in the moisture and ash contents of batches formulated with or without MDCM. A non significant change in the moisture content of MDCM was obtained by Crosland (1995). The addition of synthetic or natural antioxidant results in non significant ($P>0.05$) change in the proximate chemical analysis of burger patties formulated with or without MDCM.

Table (1): proximate chemical analysis of beef burger formulated with or without MDCM.

Treatments	Proximate analysis			
	Moisture	protein	Fat	Ash
Beef only				
Control	59.74 ± 1.42^{a}	18.92 ± 0.93^{a}	19.55 ± 0.88^{c}	1.58 ± 0.05^{a}
BHT	59.29 ± 1.27^{ab}	18.85 ± 0.97^{a}	19.22 ± 0.79^{c}	1.53 ± 0.01^{a}
Rosemary	59.68 ± 2.11^{a}	18.69 ± 1.19^{a}	18.99 ± 0.95^{c}	1.47 ± 0.06^{a}
Marjoram	59.17 ± 1.67^{abc}	18.55 ± 1.56^{a}	19.35 ± 1.01^{c}	1.43 ± 0.04^{a}
Beef + MDCM				
Control	58.29 ± 1.29^{abc}	14.37 ± 0.99^{b}	25.44 ± 0.94^{b}	2.17 ± 0.07^{a}
BHT	57.78 ± 1.71^{bc}	13.97 ± 0.87^{b}	26.22 ± 0.89^{ab}	1.86 ± 0.03^{a}
Rosemary	57.83 ± 1.81^{bc}	14.12 ± 0.89^{b}	25.96 ± 1.04^{ab}	2.51 ± 0.05^{a}
Marjoram	57.59 ± 1.28^{c}	13.76 ± 1.09^{b}	26.76 ± 0.97^{ab}	2.93 ± 0.12^{a}
Rosemary + Marjoram	57.81 ± 1.93^{bc}	13.18 ± 0.98^{b}	27.31 ± 1. 12^{a}	2.15 ± 0.08^{a}

Data represent averages of three repeats

A-cValues with different letters within a column are significantly different ($P < 0.05$)

Determination of TBA values has been found to be a good indicator for lipid oxidation in meat and meat products (Fernandez-lopez et al., 1997). The TBARs values of different formulas of burgers are presented in Table 2. Burger patties formulated with 20 % MDCM showed significantly (P<0.05) higher TBARs values than burger patties that formulated without MDCM, moreover addition of BHT did not significantly (P>0.05) reduce TBARs in burger formulas with or without MDCM. However, addition of herbal extracts (marjoram or rosemary) significantly (P<0.05) reduced the TBARs in burger patties formulated with or without MDCM. Treatment of burger patties contain 20 % MDCM with combination of marjoram and rosemary resulted in more reduction in TBARs (synergistic effect), since, the TBARs of patties treated with the combination of herbal extract were significantly (P<0.05) lower than TBARS of patties treated with marjoram or rosemary alone. The TBARs values of all formulas of burger patties increased during frozen storage. TBARs values of burger patties formulated with 20 % MDCM without antioxidants reached a higher level than the permissible limit (1.0) at the end of 3rd month of frozen storage associated with a warmed over flavor with reduction of sensory scores. Boles and Parrish (1990) reported that a warmed over falvor could be observed in meat products at TBARs

values above 1.0. However, burger patties formulated without MDCM or formulated with MDCM and treated with synthetic antioxidants (BHT) or natural herbal extracts remained within the permissible limit of TBARs until the end of frozen storage with higher sensory scores. This observation is consistent with Mielnik et al. (2003) who observed lower TBARs values for samples of mechanically deboned turkey meat treated with natural antioxidants.

Table (2): Thiobarbituric acid values (mg malonaldehyde per kg) of beef burger patties formulated with or without MDCM during frozen storage

Treatments	Storage period (TBA)			
	0-time	1st month	2nd month	3rd month
Beef only				
Control	0.554 ± 0.02 ^{b}	0.574 ± 0.01 ^{bc}	0.605 ± 0.01 ^{b}	0.665 ± 0.01 ^{c}
BHT	0.533 ± 0.02 ^{bc}	0.534 ± 0.01 ^{c}	0.612 ± 0.01 ^{b}	0.652 ± 0.03 ^{c}
Rosemary	0.351 ± 0.03 ^{e}	0.345 ± 0.03 ^{e}	0.359 ± 0.01 ^{d}	0.428 ± 0.01 ^{d}
Marjoram	0.434 ± 0.03 ^{d}	0.424 ± 0.04 ^{d}	0.468 ± 0.04 ^{c}	0.530 ± 0.04 ^{cd}
Beef + MDCM				
Control	0.702 ± 0.02 ^{a}	0.789 ± 0.02 ^{a}	0.847 ± 0.07 ^{a}	1.377 ± 0.15 ^{a}
BHT	0.669 ± 0.01 ^{a}	0.719 ± 0.08 ^{a}	0.842 ± 0.02 ^{a}	0.891 ± 0.05 ^{b}
Rosemary	0.495 ± 0.07 ^{c}	0.528 ± 0.08 ^{c}	0.577 ± 0.07 ^{b}	0.656 ± 0.06 ^{c}
Marjoram	0.575 ± 0.04 ^{b}	0.618 ± 0.03 ^{b}	0.624 ± 0.06 ^{b}	0.672 ± 0.01 ^{c}
Rosemary + Marjoram	0.351 ± 0.04 ^{e}	0.443 ± 0.05 ^{d}	0.532 ± 0.11 ^{bc}	0.582 ± 0.04 ^{cd}

Data represent averages of three repeats.

A-eValues with different letters within a column are significantly different ($P < 0.05$)

The higher TBARs values for burger patties formulated with MDCM indicate high oxidation potential for MDCM. The high oxidation potential of MDCM may be explained by the fact that the mechanical process for removing meat from the bone exerts extreme mechanical stress with cell breakage resulting with extraction of considerable quantities of lipids and heme components from bone marrow and the inclusion of oxygen in the MDCM due to reduction of its size during extrusion process. These factors promote the auto-oxidation of polyunsaturated faty acids present primarily in the phospholipids derived from bone marrow (Moerck and ball, 1974; Lee et al., 1975; Froning, 1976; Dawson and Gartner, 1983). It has been stated by Püssa et al. (2008) that MDCM contain about ten times more polyunsaturated fatty acids and also more

hemoproteins than hand boned meat and essentially more susceptable to chemical and biochemical oxidation. The reduction of the TBARs values with natural herbal extracts is probably due to the antioxidant activity of polyphenols. It has been reported by several authors that polyphenol antioxidants significantly reduce the rate of the oxidation process in food stuffs (Frankel, 1991; Pokarney, 1991; Cuvelier et al., 1996; Karpinska et al., 2001).

The effectiveness of rosemary essential oil as an inhibitor of lipid oxidation in meat products has been documented (McCarthy et al., 2001; Estévez and Cava, 2006). Barbut et al. (1985) reported that rosemary oleoresin was as efficient as a mixture of BHT and BHA in suppressing the lipid oxidation in breakfast sausage containing 25% mechanically deboned turkey meat stored fro 2 weeks.

It is clear that natural herbal extracts is more effective for protection against lipid oxidation than synthetic oxidants. This observation is consistent with Gow et al., (1996), Chen et al., (1998) Wanasundar and shahidi, (1996) and Wanasundar and shahidi, (1998).

The pH values all batches of burger patties formulated with 20 % MDCM were significantly ($P<0.05$) higher than those of batches formulated without MDCM (Table 3). The higher pH values of burger patties formulated with MDCM was probably attributed to the high pH values of MDCM. Grunden et al. (1972) and Uebersax et al. (1978) reported high pH values for MDCM. They attributed the increase of pH values to the incorporation of bone marrow constituents and protien denaturation during mechanical debonning process. High pH values were also reported for MDCM and meat emulsions formulated with MDCM by Saricoban et al., (2008). Addition of 20% mechanically deboned pork meat significantly increased the final pH values of frankfurter (Wimmer et al. 1993). Also formulation of chicken nuggest with MDCM significantly increased the pH values (Perlo et al. 2006).

Table (3): pH values of beef burger patties formulated with or without MDCM during frozen storage.

Treatments	Storage period (pH)			
	0-time	1st month	2nd month	3rd month
Beef only				
Control	5.930 ± 0.02 ^{c}	5.953 ± 0.01 ^{ef}	6.006 ± 0.02 ^{d}	6.140 ± 0.04 ^{c}
BHT	5.933 ± 0.05 ^{c}	5.943 ± 0.02 ^{f}	6.006 ± 0.04 ^{d}	6.080 ± 0.01 ^{d}
Rosemary	5.973 ± 0.02 ^{c}	5.980 ± 0.01 ^{d}	6.016 ± 0.03 ^{d}	6.070 ± 0.02 ^{d}
Marjoram	5.973 ± 0.01 ^{c}	5.963 ± 0.03 ^{de}	6.047 ± 0.06 ^{d}	6.140 ± 0.05 ^{c}
Beef +MDCM				
Control	6.110 ± 0.01 ^{a}	6.283 ± 0.02 ^{a}	6.270 ± 0.05 ^{a}	6.310 ± 0.03 ^{a}
BHT	6.120 ± 0.01 ^{a}	6.296 ± 0.02 ^{a}	6.206 ± 0.01 ^{a}	6.323 ± 0.02 ^{a}
Rosemary	6.090 ± 0.03 ^{b}	6.140 ± 0.04 ^{b}	6.153 ± 0.04 ^{bc}	6.156 ± 0.02 ^{c}
Marjoram	6.093 ± 0.02 ^{b}	6.136 ± 0.02 ^{b}	6.193 ± 0.02 ^{b}	6.216 ± 0.01 ^{b}
Rosemary + Marjoram	6.050 ± 0.01 ^{b}	6.080 ± 0.01 ^{c}	6.160 ± 0.03 ^{bc}	6.160 ± 0.02 ^{c}

Data represent averages of three repeats
A-fValues with different letters within a column are significantly different ($P < 0.05$)

The addition of natural antioxidants to burger patties formulated with MDCM significantly ($P<0.05$) reduced the pH values. Combinning rosemary with marjoram was more effective in reducing the pH values of burger patties formulated with MDCM during storage. Although, pH of burger paties formulated with MDCM without addition of natural antioxidants reached a higher values than permissible limit after 3 monthes of frozen storage, the pH values of burger patties formulated with MDCM and treated with natural antioxidants remained within the permissible limit until the end of storage period (3 months).

Psychrotrophic counts of all batchs of burger patties formulated with 20 % MDCM were significantly ($P<0.05$) higher than those of burger patties formulated without MDCM (Table 4). This high counts were probably attributed to the high microbial counts of MDCM. The MDCM has high microbial load due to contamination during processing. The large surface area due to reduction of particle size, the extraction of cellular contents rich in nutrients due to tissue maceration and the heat generated during mechanical debonning, all these factors promote bacterial growth. Therefore, MDCM is highly perishable and has a short shelf life even under refrigerated storage (Ray et al., 1984; Kumar et al., 1986; Fjeld et al., 1988; Gill, 1988). Higher pH values of MDCM probably enhance the growth of microorganisms (Yuste et al., 1998).

Addition of antioxidants did not significantly (P>0.05) reduce the pychrotrophic counts in all burger patties during storage untill the 2nd month of storage. At the end of 3rd month of storage, counts of pychrotrophic microbiota of burger patties formulated with 20 % MDCM without antioxidants were higher than 7 log10cfu/g which is considered spoilage level for this type of product (Jackson et al., 1997). However, pychrotrphic counts of burger patties formulated with MDCM and treated with antioxidants or formulated without MDCM remained within the permissible limit (less than 7 log10cfu/g) until the end of three months of frozen storage.The reduction of pH values due to treatments with antioxidants may be the cause for lowering of bacterial counts of burger formulated with MDCM at the 3rd month of storage.

Table (4): Psychrotrophic bacterial counts (expressed as Log CFU/ g) of beef burger during frozen storage

Treatments	Storage period (Psychrotrophs)			
	0-time	1st month	2nd month	3rd month
Beef only				
Control	5.654 ± 0.05 ^{c}	5.685 ± 0.09 ^{f}	5.729 ± 0.06 ^{f}	6.896 ± 0.1 ^{b}
BHT	5.663 ± 0.08 ^{c}	5.675 ± 0.14 ^{e}	5.892 ± 0.09 ^{e}	6.894 ± 0.03 ^{b}
Rosemary	5.382 ± 0.1 ^{d}	6.140 ± 0.2 ^{d}	6.346 ± 0.06 ^{d}	6.797 ± 0.07 ^{b}
Marjoram	5.625 ± 0.2 ^{c}	5.894 ± 0.12 ^{e}	5.905 ± 0.06 ^{e}	7.109 ± 0.22 ^{b}
Beef +MDCM				
Control	6.566 ± 0.04 ^{a}	6.885 ± 0.03 ^{a}	6.856 ± 0.05 ^{a}	8.467 ± 0.44 ^{a}
BHT	6.328 ± 0.01 ^{b}	6.658 ± 0.07 ^{bc}	6.775 ± 0.11 ^{ab}	7.655 ± 1.4 ^{b}
Rosemary	6.725 ± 0.03 ^{a}	6.611 ± 0.07 ^{c}	6.627 ± 0.15 ^{bc}	7.564 ± 0.06 ^{b}
Marjoram	6.680 ± 0.16 ^{a}	6.825 ± 0.03 ^{ab}	6.858 ± 0.06 ^{a}	7.625 ± 0.04 ^{b}
Rosemary + Marjoram	6.165 ± 0.11 ^{b}	6.546 ± 0.04 ^{c}	6. 592 ± 0.08 ^{c}	7.225 ± 0.13 ^{b}

Data represent averages of three repeats
A,fValues with different letters within a column are significantly different (P < 0.05)

Sensory scores of all batches of burger patties are presented in Table 5. The flavor and overall acceptance scores of burger patties formulated with 20 % MDCM that did not treated with antioxidants were significantly ($P<0.05$) lower than the other burger patties. A chicky flavor was detected by panelists in the burger patties formulated with MDCM without antioxidants. The scores of this formula decreased during frozen storage and reached unacceptable level (5) by the end of 3rd month of frozen storage with development of warmed over flavor. Marked rancid flavor was detected for comminuted sausage formulated with mechanically deboned turkey meat stored for 18 weeks by Mielnik et al. (2002).

Addition of antioxidants to the burger patties significantly ($P<0.05$) increased the sensory scores during the frozen storage period. The sensory scores of burger patties formulated with MDCM and treated with antioxidants remained within the acceptable level untill the end of storage period. The high oxidation potential of fatty acids present in MDCM resulted in generation of secondary products of fatty acid auto-oxidation such as aldehydes, ketones, hydrocarbones, esters, fuirans and lactans. These products are probably responsible for sensory deterioration during storage (Ladikos and Lougovois, 1990; Froning, 1995; Kannatt et al., 1997). The reduction of the rate of lipid oxidation by antioxidants during storage probably prevents the formation of secondary oxidation products and consequently decreases the rate of sensory deterioration.

Table 5: Sensory attributes of beef burger manufactured with or without MDCM and treated with natural antioxidants during frozen storage

Treatments	flavor				Tenderness				Juiciness				Overall acceptability			
	0-time	1st month	2nd month	3rd month	0-time	1st month	2nd month	3rd month	0-time	1st month	2nd month	3rd month	0-time	1st month	2nd month	3rd month
Beef Only																
Control	9.1±0.6^{a}	9.0±1.0^{a}	7.8±0.6^{a}	7.6±0.6^{a}	9.0±0.1^{a}	8.6±1.0^{a}	7.8±0.6^{a}	7.3±1.0^{a}	8.8±0.3^{a}	8.6±1.0^{a}	7.6±0.6^{a}	7.0±0.5^{a}	9.3±0.6^{a}	8.6±0.6^{a}	7.6±1.0	7.0±1.0
BHT	8.9±0.5^{a}	8.8±0.5^{a}	7.6±0.6^{a}	7.6±0.6^{a}	8.6±0.3^{a}	8.3±0.6^{a}	7.3±0.6^{a}	7.0±0.6^{a}	8.8±0.3^{a}	8.3±0.3^{a}	7.5±0.6^{a}	68±0.6^{a}	8.1±0.3^{b}	8.5±0.7^{a}	7.0±0.5	6.3±0.5
Rosemary	8.9±0.5^{a}	8.9±0.6^{a}	7.8±0.6^{a}	7.5±1.0^{a}	9.0±0.1^{a}	8.6±0.3^{a}	7.6±1.0^{a}	6.6±1.0^{b}	8.7±0.5^{a}	8.0±0.1^{a}	7.5±0.3^{a}	6.9±0.1^{a}	8.9±0.6^{a}	8.5±0.5^{a}	7.6±0.5	6.6±0.5
Marjoram	8.8±0.3^{a}	8.9±0.8^{a}	7.6±0.5^{a}	7.6±0.6^{a}	8.8±0.3^{a}	8.6±0.3^{a}	7.6±0.6^{a}	7.0±0.2^{a}	8.7±0.5^{a}	8.3±0.6^{a}	7.6±0.6^{a}	6.9±0.6^{a}	9.1±0.6^{a}	8.3±0.7^{a}	7.5±0.5	6.6±0.5
Beef + MDCM																
Control	7.5±0.5^{b}	7.5±0.1^{b}	7.0±1.0^{b}	3.6±0.6^{c}	7.6±0.1^{b}	7.5±0.6^{b}	7.3±0.6^{b}	4.5±1.0^{c}	8.3±0.5^{b}	7.8±0.3^{b}	7.0±0.1^{b}	4.3±1.0^{b}	8.3±0.8^{b}	8.0±0.8^{b}	7.0±1.0	4.5±0.5
BHT	7.5±0.9^{b}	7.1±0.3^{b}	6.6±0.6^{b}	6.3±0.6^{b}	7.6±1.0^{b}	7.6±0.5^{b}	7.6±1.0^{c}	6.8±1.0^{b}	8.3±0.5^{b}	7.6±0.6^{b}	6.3±0.6^{c}	6.6±0.6^{c}	7.6±0.5^{c}	7.9±0.5^{b}	6.6±1.1	6.3±0. ^{b}
Rosemary	8.9±0.5^{a}	8.0±1.0^{c}	7.5±0.6^{a}	6.8±0.8^{b}	7.8±0.5^{bc}	7.6±0.6^{bc}	7.3±1.0^{b}	7.0±0.5^{a}	8.0±0.6^{c}	8.0±1.0^{a}	6.6±0.6^{c}	6.6±0.5^{c}	8.8±0.3^{a}	8.5±0.7^{a}	7.0±1.0	6.0±1.0
Marjoram	8.8±0.3^{a}	8.1±0.3^{c}	7.7±0.6^{a}	6.6±0.7^{b}	8.6±0.6^{c}	8.6±0.6^{c}	7.3±06^{b}	6.6±1.0^{b}	8.6±1.0^{a}	8.0±1.0^{a}	7.0±0.1^{b}	6.8±0.6^{a}	8.6±0.6^{a}	8.6±0.2^{a}	7.3±0.5	6.6±0.5
Rosemary + Marjoram	8.9±0.5^{a}	8.0±0.1^{c}	7.6±0.6^{a}	6.8±1.0^{b}	8.6±0.5^{c}	8.3±0.6^{c}	7.6±0.5^{c}	7.0±0.5^{c}	8.6±0.5^{a}	8.0±0.1^{a}	7.3±0.5^{b}	7.0±0.1^{a}	8.3±0.5^{b}	8.5±1.0^{a}	7.3±1.1	6.6±0.5

Data represent averages of three repeats

A..fValues with different letters within a column are significantly different ($P < 0.05$)

From these observations, it can be concluded that MDCM is an excellent raw material for formulation of Burger patties. However, the oxidation potential and high bacterial counts of MDCM decrease the shelf life of the product. The use of antioxidants can prevent the auto-oxidation of MDCM and lower pH values with reduction of bacterial counts during storage. Consequently, antioxidants can extend the shelf life of burger patties formulatred with MDCM. Natural herbal extracts specially when combined together offered the most efficient protection against lipid oxidation with improving the sensory attributes at levels applied during frozen storage of burger patties formulated with 20 % MDCM.

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استخدام المستخلصات الطبيعية للأعشاب لتحسين ثبات الليبيدات والخواص الحسية للبرجر المصنع من مفروم الدواجن المنزوعة العظم ميكانيكيا"

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الهدف الرئيسى من هذه الدراسة هو تقليل الأكسدة الدهنية وتحسين الخواص الحسية و إطالة فترة الحفظ للبرجر المصنع من مفروم الدواجن المنزوعة العظم ميكانيكيا"باستخدام المستخلصات الطبيعية للأعشاب . تم تحضير عجينة لحوم باستخدام المكونات التالية: ٥٠ % لحم بقرى أحمر، ٣٥ % دهن بقرى، ٢% ملح طعام، ٥% ماء و ٨% صويا. ثم تقسيم هذه العجينة الى أجزاء إضافة المستخلصات الطبيعية للاعشاب (البردقوش وحصا اللبان) بنسبة ٠,٠٢ كما تم الاحتفاظ بجزء بدون اضافة المستخلصات. كما تم تحضير خمس أجزاء أخرى باضافة ٢٠% مفروم الفراخ (نسبة من الحم الأحمر) إضافة المستخلصات إليها بنفس النسب كما تم تحضير مجموعة بدون مستخلصات وأخرى باستخدام كل من البردقوش وحصا اللبان معا. وقد تم أخذ العينات على فترات زمنية لتحليلها من حيث قيمة حامض الثيوباربتيوريك و درجة الأس الهيدروجينى والخواص الحسية والعد الكلى للميكروبات المحبة للبرودة. وقد أوضحت النتائج أن إضافة مستخلص كل من البردقوش وحصا اللبان أدى إلى حدوث إنخفاض ملحوظ فى قيمة حامض الثيوباربتيوريك في كل من المجموعات المصنوعة باستخدام مفروم الفراخ أو المصنوعة بغير مفروم الفراخ. فضلا عن أن إضافة المستخلصات الطبيعية للاعشاب الى انخفاض درجة الأس الهيدروجينى. وقد لوحظ أيضا أنه عند إضافة المستخلصات الطبيعية للأعشاب أدي حدوث ازدياد ملحوظ في الخواص الحسية للبر جر المصنع من مفروم الفراخ. ولذلك فإن استخدام المستخلصات الطبيعية للاعشاب وخاصة عندما تستخدم معا فانها تؤدى الى تحسين ثبات الليبيدات والخواص الحسية واطالة فترة الصلاحية للبرجر المصنع من مفروم الفراخ ٠