DECOCTIONS OF NORWEGIAN HERBS STABILISE MARINATED TURKEY THIGHS

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Background

One of the major problems during the processing and storage of meat and meat products is lipid oxidation. This process initiates several changes, which adversely affects the products' colour, flavour, texture and nutritional value. Rancidity in pre-cooked products, especially made from turkey meat, is a great challenge for the food industry. Lipid stability in processed poultry meat may be improved by various components added or injected into the meat during a marination process (Mielnik *et al.,* 1996). The composition of the brine influences the course of chemical reactions, which in turn affect oxidative stability.

The major strategies for preventing lipid oxidation are the use of free radical scavengers such as phenolic antioxidants. In the past few years a variety of plant materials containing phenolic compounds has been proved to be effective antioxidants in model systems. Herbs and spices were traditionally added to food for improving sensory properties and as antioxidants and preservatives. Many herbs and spices rich in polyphenols exhibit antioxidative activities similar to those of synthetic phenolic antioxidants (Cuvelier *et al.,* 1996). Since ancient times, herbs and spices have been used to prolong shelf life and improve the taste of meat products. In various studies, herbs of the mint family (*Labiatae*) have exhibited powerful antioxidant activity (Madsen and Bertelsen, 1995; Herrmann, 1981; Chipault *et al.,* 1956). Marination, originally used for the preservation and tenderisation of meat, is nowadays applied by industry and restaurants to give meats new and exciting tastes and appearances. Marketing of marinated poultry parts is one of the fastest growing segments of the food industry around the world.

Objectives

The presented study was carried out to examine the effect of marinades made with decoction from rosemary, sage and thyme on the oxidative stability of turkey thighs, pre-cooked and chill-stored for one week.

Materials and methods

Marinating of turkey thighs

The turkey thighs were obtained from a local processing plant the day after slaughter. Cuts of thigh meat without skin were soaked in one of five different marinades. Decoctions of rosemary, sage and thyme obtained from Norske Eteriske Oljer A/S were used to prepare three of them. These marinades consisted of decoction with 12% salt. The fourth marinade consisted of 12% salt and 160 mg/L butylated hydroxyanisole (BHA) in water. Water with salt (12 %) and no antioxidant was used as a control. The turkey meat cuts were wiped with paper towel after overnight marination and were vacuum packed in plastic bags (ca 450 g). The samples were cooked in a water bath at 85 °C for 30 min and cooled for 45 min in running water. The meat cuts were divided into smaller portions, transferred to plastic boxes covered with aluminium foil to get air-exposure, and stored for 7 days in the dark at 4 °C.

Chemical methods

Antiradical power (ARP)

The antioxidant activity of the different marinades were determined by using the 2,2-diphenyl-1-picrylhydrazyl ($DPPH^{\cdot}$) method according to the procedure described by Brand-Williams *et al.* (1995) with some modifications (Mielnik *et al.*, 2003). Antioxidant activity was expressed as antiradical power (ARP) in units of mg $DPPH^{\cdot}$/ml marinade.

Thiobarbituric acid reactive substances (TBARS)
The TBARS values were determined by the extraction method according to Sørensen and Jørgensen (1996). Results expressed as mg malondialdehyde (MDA)/kg meat, were calculated from a standard curve of TEP (1,1,3,3-tetraethyoxypropane). TBARS values were examined before and after marinating, directly after cooking and after 1, 3, 5 and 7 days of chill-storage at 4 °C in the dark.

Hexanal
Analysis of hexanal formed during 5 days of storage at 4 °C in marinated cooked turkey thighs was performed by a dynamic headspace technique as described earlier (Mielnik *et al*., 2002). Semi-quantitative amounts of the volatile compound were obtained by relating peak intensities to that of the internal standard ethyl heptanoate (ng), weight of meat sample (g) and total volume of purging gas (L), giving the units ng/g x L.

Sensory analysis
The marinated cooked turkey thighs were evaluated after 5 days of storage at 4 °C. Prior to serving, meat samples sealed in vacuum pouches were heated in a water bath at 70 °C for 30 min. Sensory analysis was performed according to international standard methods (ISO 1985). The panel, consisting of eleven trained assessors, carried out a descriptive test (ISO 1985). Prior to the analysis the panel was trained in the definition and intensities of odours (turkey, acidulous, spicy, rancid), flavours (turkey, acidulous, salt, spicy, bitter, metallic, rancid), colour (whiteness, hue, intensity) and texture attributes (hardness and juiciness). Samples from each marinade were served twice in a warm steel cup with a lid. Serving order was randomised according to sample, replicate and assessor. Each panellist evaluated the samples at individual speed on a computerised system for direct recording of data (CSA, Compusense, Version 4.2, Guelph, ON, Canada) using value 1.0 for the lowest intensity and value 9.0 for the highest intensity of each attribute.

Data analysis
Two replications were carried out with all samples. Effects of marinade and storage time on TBARS values were analysed by ANOVA. The main trends of variation among the samples were studied by principal component analysis (PCA) using the Unscrambler version 8.05 software program (CAMO, Oslo, Norway). The variables were mean-centred prior to PCA. All variables were standardised by 1/standard deviation and full cross-validation was used for the model validation (Martens and Næs, 1989).

Results and discussion

Antiradical Power (ARP) of marinades
The $DPPH^{\cdot}$ radical scavenging activities of the marinades applied in the present study are shown as antiradical power (ARP) in Table 1. The rosemary marinade showed the highest ARP values which means that this marinade had the highest antioxidative activity. Thyme and sage marinades showed considerably lower antioxidative activity compared with the rosemary marinade; 36.9 % and 10.7 % lower, respectively. The BHA marinade had the lowest antiradical power.

Table 1. ARP (mg DPPH/ml marinade) for tested marinades

Marinade	Rosemary	Sage	Thyme	BHA
ARP	85.7	9.2	31.6	1.2

TBARS values
TBARS values measured in the turkey thigh meat showed that both the marinating process and the heat treatment affected the oxidation rate (Table 2). The control samples soaked in 12% salt solution had significantly higher TBARS values than samples soaked in 12% salt solution with decoction of herbs or BHA. TBARS values in control samples were 13 times higher than in the other samples. The differences between turkey thighs marinated with various antioxidants were not significant.

Table 2. Evolution of TBARS values (mg malondialdehyd/kg meat) in turkey thighs during marination, cooking and dark storage at 4 °C in air

Marinade	Raw meat	Marinated meat	Cooked and stored meat (days)				
			0	1	3	5	7
Rosemary	0.15	0.14 ^{b}	0,12 $^{c}{}_{v}$	0,39 $^{e}{}_{w}$	0,82 $^{e}{}_{x}$	1,45 $^{e}{}_{y}$	2,33 $^{e}{}_{z}$
Sage	0.15	0.12 ^{b}	0,63 $^{b}{}_{v}$	0,75 $^{c}{}_{w}$	2,40 $^{b}{}_{x}$	2,55 $^{c}{}_{y}$	3,87 $^{c}{}_{z}$
Thyme	0.15	0.14 ^{b}	0,09 $^{c}{}_{v}$	0,66 $^{d}{}_{w}$	1,50 $^{d}{}_{x}$	1,77 $^{d}{}_{y}$	3,35 $^{d}{}_{z}$
BHA	0.15	0.12 ^{b}	0,18 $^{c}{}_{v}$	1,09 $^{b}{}_{w}$	1,88 $^{c}{}_{x}$	3,21 $^{b}{}_{y}$	4,15 $^{b}{}_{z}$
Control	0.15	1.91 ^{a}	7,38 $^{a}{}_{x}$	7,32 $^{a}{}_{x}$	7,69 $^{a}{}_{yx}$	8,28 $^{a}{}_{zy}$	8,45 $^{a}{}_{z}$

$^{a\text{-}e}$ Means with different letters within a column are significantly different at $p < 0.05$.
v-z Means with different letters within a row are significantly different at $p < 0.05$.

The highest TBARS values, measured directly after cooking, were obtained in the control samples without antioxidant. The increase was about four fold compared to raw meat soaked in salt solution, while turkey thigh marinated with rosemary and thyme showed no increase in TBARS values from raw state through marinating and cooking. Meat marinated in rosemary or thyme marinades had the lowest TBARS values; 1.6% and 1.2% of the TBARS value noticed in control samples, respectively. The results demonstrated that marinating with herbs reduced oxidation both during marinating and cooking. However, cooked meat marinated in sage showed significantly higher TBARS values compared with raw and marinated samples and with meat treated with the other herb marinades.

Oxidative rancidity measured as TBARS values increased during storage in all samples. The highest rises in TBARS over time were seen in the control samples without added antioxidant. Meat from the rosemary marinade had the lowest TBARS values throughout the storage period although the development in oxidation increased continually. TBARS values in meat marinated with thyme, sage and BHA also increase during storage, but the TBARS values were significantly higher than those with rosemary. BHA had the lowest stabilising effect among the antioxidants.

Hexanal, a typical off-flavour volatile is often used as an indicator for lipid degradation and rancidity. In raw and marinated turkey thigh meat the amount of hexanal was negligible until cooking (results not shown). After cooking and later during chill storage, the amount of hexanal increased considerably especially in the control samples. The rosemary decoction was most efficient in retarding the formation of hexanal.

The PCA showed that the two first principal components described 81% of the variation between samples treated with different marinades. The loading plot (Fig.1) illustrates contributions of the scaled variables to the PCs. The first principal component appears to be composed of spicy and acidulous flavour together with juiciness on one side. These variables were highly correlated to each other and gave high negative loadings. On the opposite side, rancidity attributes like rancid and metallic flavour, TBARS and hexanal as well as hardness contributed to the positive loadings. The second principal component was mainly related to bitter flavour. The pattern in the score plot showed that control samples were strongly related to the variables describing development in oxidation while the meat marinated with decoction of herbs, especially rosemary, had high scores for spicy and acidulous flavour. However, the turkey thigh marinated with rosemary was assessed as the most bitter among the samples.

Conclusions

Utilisation of herb decoctions may have a great potential in the catering sector in order to prevent the development of rancidity in stored heat-treated meat products. This study showed that decoctions, as by-products from distillation of essential oils, could be used as a source of antioxidants in marinades. However, procedures need to be standardised, and the decoction should undergo further processing before being used commercially.

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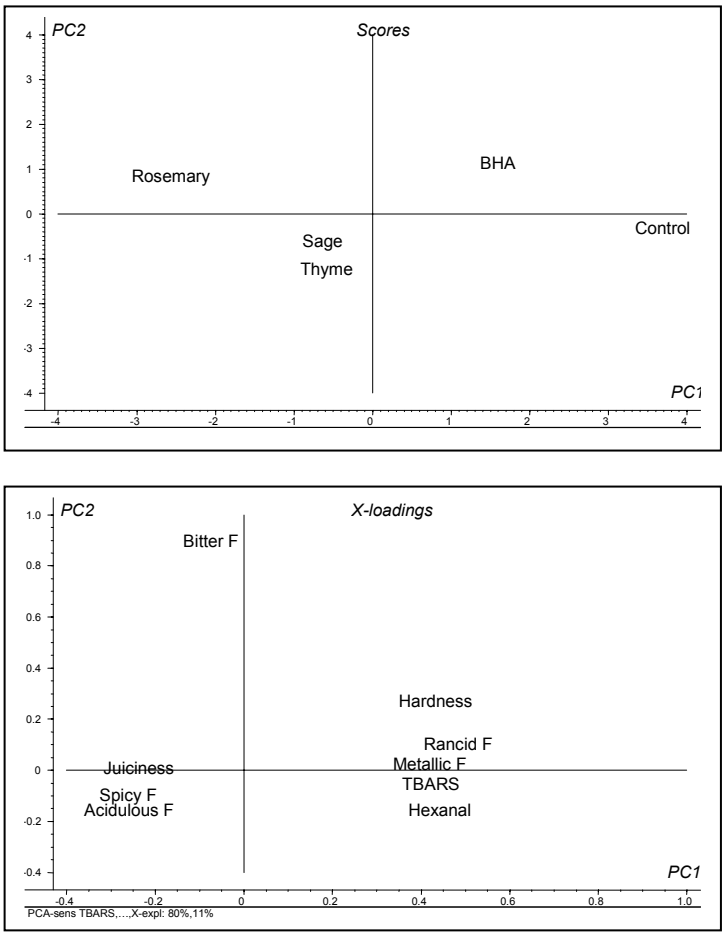

Figure 1. Score and loading plot for PC1 and PC2 obtained from PCA of sensory attributes analysed together with TBARS and§ hexanal measured in marinated meat from turkey thigh, cooked and stored for 5 days at 4 °C. (F = flavour)